How to back up breakers with . . .

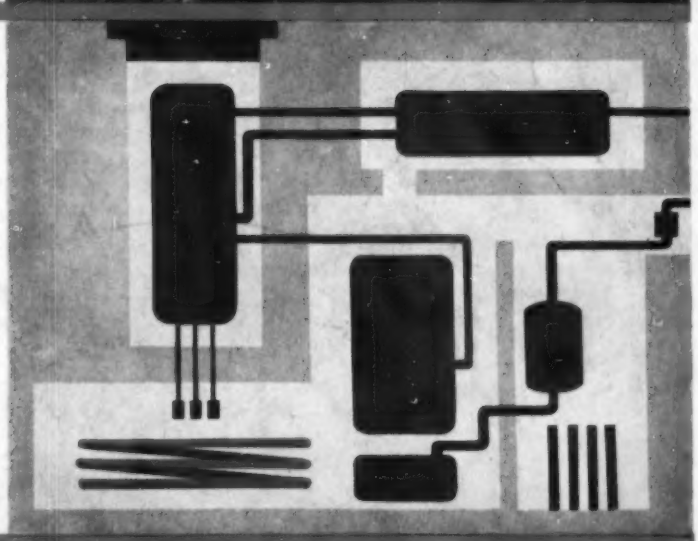
HIGH I-C CURRENT-LIMITING FUSES ▸ 116

Power

SEPTEMBER
1955·50¢

GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES • A McGRAW-HILL PUBLICATION

What Europe is doing with industrial TV . . . . . p 82



Tomorrow's nuclear reactor for small plants? . . . . . p 75

Modern aptitude tests help select plant men . . . . p 107

New self-feeding, non-plugging materials handling valves

give trouble-free flow control in the pneumatic transport of fine solid materials

No plugging of transport piping systems. A-S-H Type C Materials Handling Valves eliminate headaches that used to plague power engineers in the handling of fly ash and other fine solids. Type C Valves offer the following advantages:

Self-feeding—Atmospheric air, admitted into the vacuum system through inlet ports, continuously picks up and sweeps materials from the valve into the transport piping.

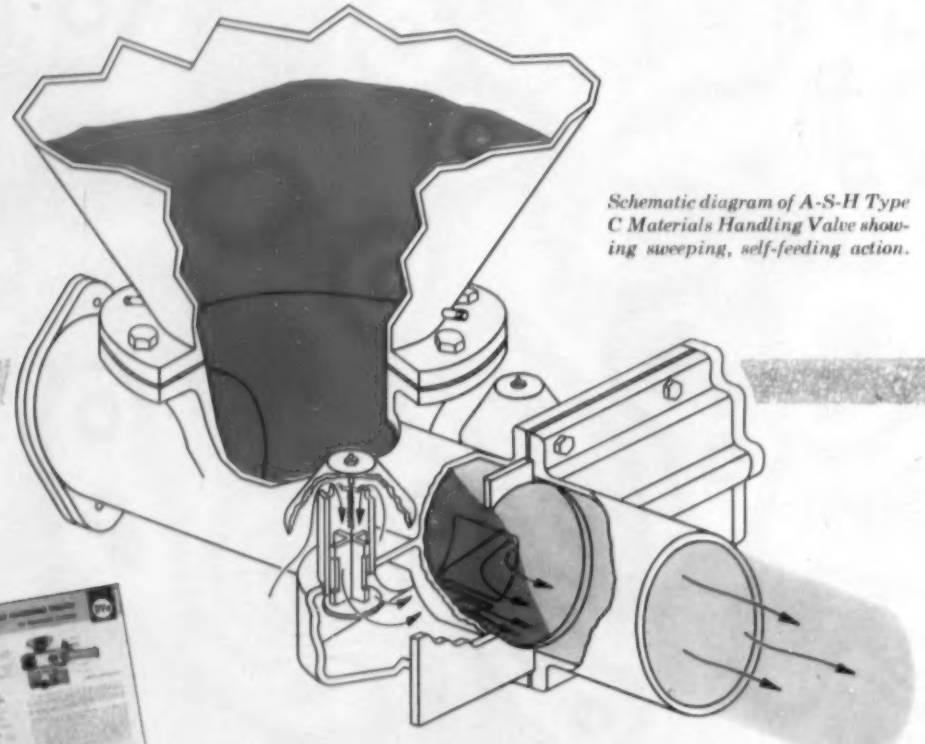
Non-plugging operation—Continuous rate of feeding, commensurate with the increases and decreases of the load, eliminates any sudden application of full vacuum which might plug the system.

Positive shut-off—Sliding gate mechanism uses vacuum in the system to keep gate slide clear . . . and to hold gate tightly against seat when valve is closed.

Maximum carrying capacity—High vacuum results in high material concentration and permits use of smaller diameter transport piping.

Minimum frictional wear—Bulk of material, at maximum concentration over full area of pipe, avoids contact with pipe walls, thus eliminating sandblasting effect of low material concentrations.

Ease of maintenance and operation—Valve can be maintained while system is in operation. A turn of a nut adjusts air inlet port openings to accommodate different materials and draft conditions. Type C valves are designed for air-electric, remote and manual operation. A post card requesting information on A-S-H Type C materials handling valves will bring you complete technical data promptly.



Schematic diagram of A-S-H Type C Materials Handling Valve showing sweeping, self-feeding action.

Write for your copy of Data Sheet DVa.

The **Allen-Sherman-Hoff** Company

259 E. Lancaster Ave., Wynnewood, Pa.

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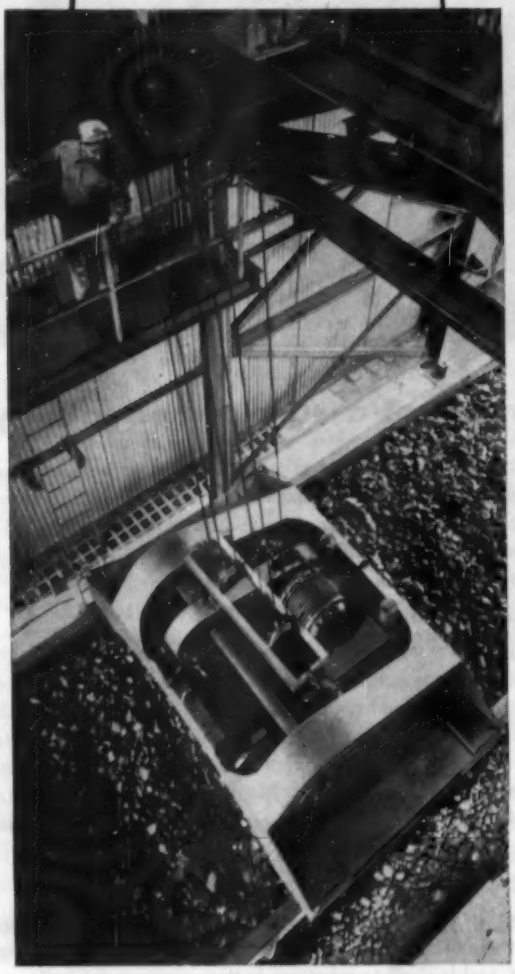
MATERIALS HANDLING SYSTEMS

hydrojet *hydraulic* / **hydrovac** *pneumatic*

How to appraise your own railroad car unloading needs

CAR SHAKERS for 15 or more cars per day



ROTARY DUMPERS for 15 or more cars per hour

Empty a 90-ton gondola car every 60 seconds or less (including return to upright position) by turning car upside down! Simple, automatic, foolproof. Takes all open-type cars—any length, width or height. Book 2048-A has complete data.

Cut unloading time—free manpower. For example, where a load of wet coal ties up three men for ¾ hours, one man with a Link-Belt Car Shaker can empty the car "broom-clean" in minutes. Exclusive low-frequency vibration minimizes noise . . . is easier on cars. Write for Book 2345.

Only LINK-BELT makes both shakers and dumpers to match all requirements

Choose a railroad car unloading system adequate to meet your needs when operating at full plant capacity. Link-Belt builds the Rotary Dumper for large plants . . . the Car Shaker for smaller operations. Precision engineered, both reduce operational hazards . . . minimize injury possibilities . . . cut costly demurrage charges.

Call your nearest Link-Belt representative. He'll gladly offer further specifics about Link-Belt Car Shakers and Rotary Dumpers . . . make a recommendation based on weight of carloads and character of your materials.

LINK-BELT

CAR SHAKERS and ROTARY DUMPERS

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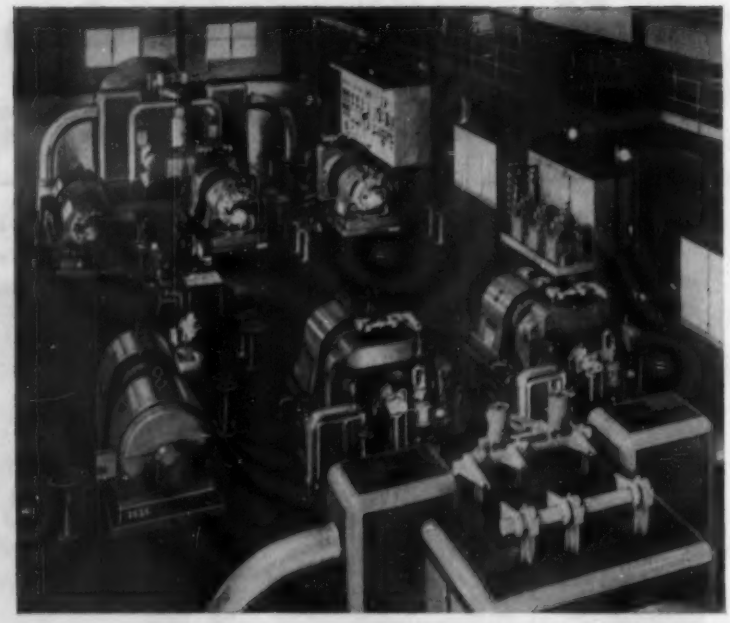
What makes a barrel-type boiler feed pump *stay in service?*



Here are some of the design features that assure dependability

Today's modern multi-stage centrifugal pumps for boiler feed service are the result of years of research and design. To provide efficient service *plus* dependability, De Laval has incorporated these important features in its barrel-type pump.

Double Volute Diaphragms

Double volute diaphragms provide for radial hydraulic balance and assure a continuous rising head characteristic from the design point to shut-off. *RESULT—Higher efficiencies are maintained over a wider range of operation than are generally obtained with other forms of velocity pressure conversion.*

Individual Diaphragm Bolting

Elimination of rabbet fits and gaskets permits straight metal-to-metal contact of adjacent lapped faces of the diaphragms which are individually bolted together to maintain tight joints and ease of assembly. *RESULT—Positive assurance against inner case leakage, complete elimination of misalignment causes and a minimum of distortion from sudden temperature changes.*

Positive Sealing Between Suction and Discharge Chamber

Inner assembly is held at the inner high pressure joint at the suction end of the barrel, against a flexitallic gasket, with through bolts. The joint between the suction and discharge chambers is made tight during assembly—remains tight whether pump is operating or idle. *RESULT—No possibility of leakage or gasket loosening due to changes of force on the inner joint.*

Bare Shaft

Bare shaft construction with split ring-shrink fit method of impeller mounting permits a scalloped shaft design and eliminates the need for spacer sleeves between impellers. *RESULT—Better hydraulic conditions at the eye of the impeller and elimination of spacer sleeves—the greatest cause of shaft warpage.*

Wearing Rings

Diaphragms and impellers have renewable wearing rings. Impeller rings are threaded on the impeller hubs against rotation, and diaphragm rings are held by a breech lock fit in the diaphragms. *RESULT—Construction permits renewal of original clearances without major part renewal or modification. Labyrinth type diaphragm ring results in minimum leakage over a longer period of time than with close clearance flat rings.*

IMO Oil Pump

A De Laval IMO pump designed for high speed operation is direct-connected to the outboard end of the barrel pump shaft, and is sized to lubricate both pump and driver bearings. *RESULT—Quiet, pulsation-free, positive displacement IMO pumps, assures positive lubrication and eliminates the need of extra shaft length and mechanical complications required by gear drive lube oil pumps.*

BULLETIN CONTAINS HELPFUL DATA

This De Laval bulletin on the barrel-type boiler feed pump covers all major design points . . . has cross-section cut-away illustration for easy reference. Write on your business letterhead for your copy of Bulletin 1506 to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey.

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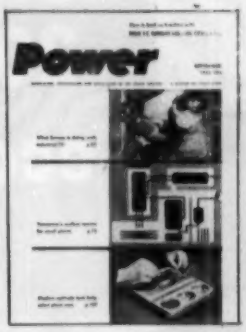


BLENDING three illustrations in a single cover, *above*, is simply a means for calling your attention to three timely articles in this issue. Another highly significant article, listed without illustration on cover's upper right corner, deals with fuses.

This article, one of the first to appear in print on high interrupting-capacity fuse and breaker selection, pins down a simple engineering approach to backing up low-voltage air circuit breakers with current-limiting fuses. The problem, as spelled out in the article, is one of electrical coordination—meaning fuse must hold on currents within breaker's rating, yet take over when current exceeds breaker's I-C.

By teaming up fuse and breaker you can save money on both old and new installations. Where high I-C fuse is used within recognized limits, it may be practical to leave existing low I-C breakers in service: use smaller breakers on new jobs.

Next month . . .

Refrigeration, latest in POWER's series of special reports, will pack into 20 pages all pertinent facts on refrigeration components, systems, applications.

In scanning manuscript of this latest report by Associate Editor Ty Hicks, many trends are apparent. For these trends plus basics, read this report.

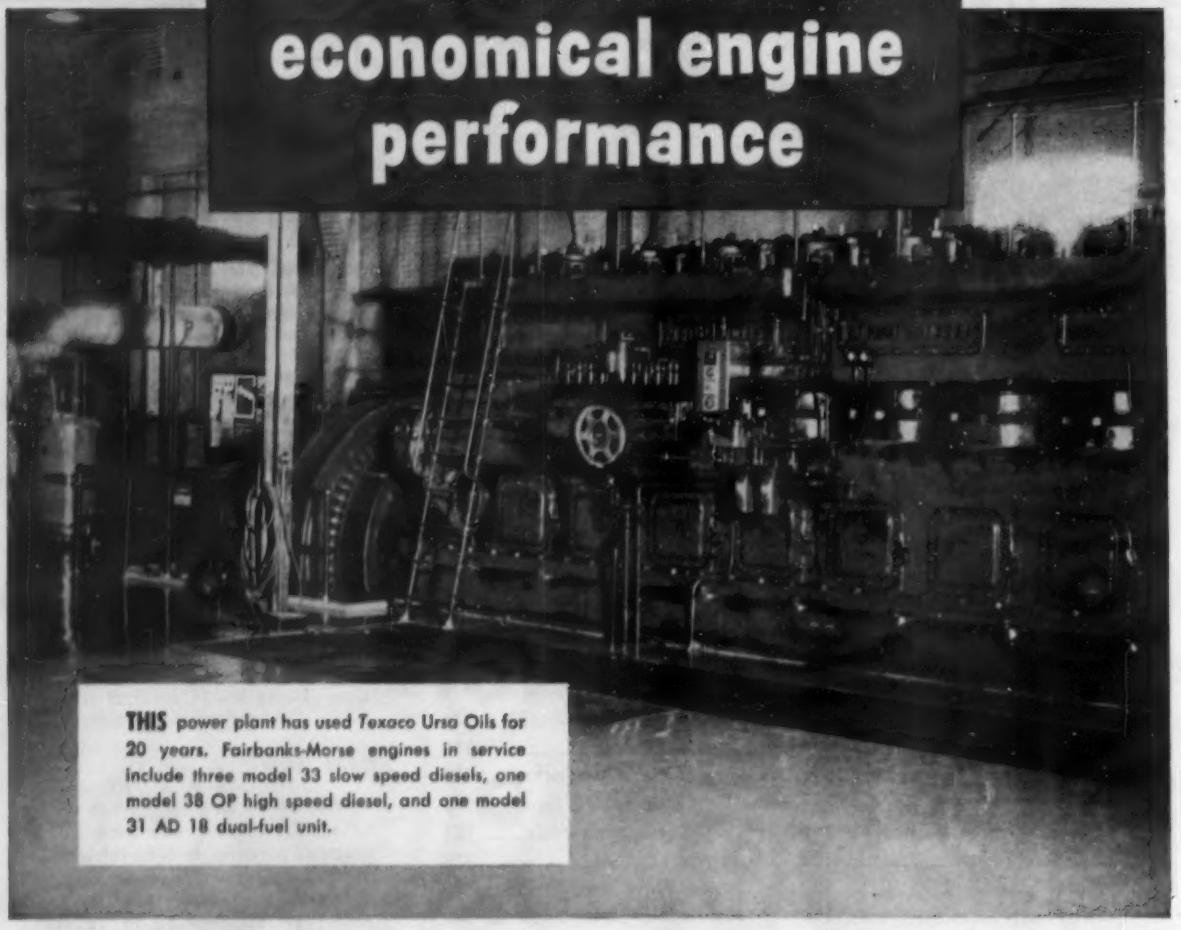
High-voltage controllers are news now among power men since NEMA abandoned their Class A designation. Latest is Class E, considered standard for high-voltage-motor branch circuits. This article gives you info behind the change.

Reactor investment and fuel-processing costs call for heavy research before nuclear plants can compete with conventional steam plants. These are typical of problems to be tackled in Battelle Memorial's new nuclear research laboratory, first such lab built with private capital in the U.S. Details on facilities, next issue.

. . . and future months

Atomic Energy Today, a 24-page round-up of what's happening in the fast-moving nuclear field and what it means to power men, will appear in the December issue. Watch for it!

20 years of clean, economical engine performance



THIS power plant has used *Texaco* Ursa Oils for 20 years. Fairbanks-Morse engines in service include three model 33 slow speed diesels, one model 38 OP high speed diesel, and one model 31 AD 18 dual-fuel unit.

THIS plant (name on request) operates both straight diesel and dual-fuel engines – all of them lubricated with *Texaco Ursa Oil*. The Plant Superintendent says:

"Never, in more than 20 years, has Texaco Ursa Oil 'let us down.' Our engines stay clean, wear is negligible, and we enjoy real fuel economy."

This experience is typical. *Texaco Ursa Oil* does a great job of keeping engines clean. It stands up under heat and pressure . . . stands off oxidation and sludging . . . keeps rings free for proper compression and combustion. This means you'll use less fuel . . . spend less for maintenance.

There is a complete line of *Texaco Ursa Oils* to give your diesel, gas or dual-fuel engines the best "run" for your money. Leading engine builders O.K. them, operators everywhere use them. In fact–

For over 20 years, more stationary diesel h.p. in the U.S. has been lubricated with Texaco than with any other brand.

Get the full story from your Texaco Lubrication Engineer. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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TEXACO URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

TUNE IN . . . TEXACO STAR THEATER starring JIMMY DURANTE on television . . . Saturday nights, NBC.

speaking of **Power**

Those who carry the technical gospel to foreign lands

Mileret and the Sphinx

Circulation representative Jack Mileret, *left*, unlike most McGraw-Hill reps, has a free afternoon daily while covering the North African territory. He spends the time sightseeing. But there's a catch: All business is resumed again and the workday completed after the 4½-hour siesta.

Getting to see potential subscribers is a relatively quiet operation here in the United States. But our circulation men abroad often run into interesting and sometimes dangerous situations. We were reminded of this the other day when Huber Gemmill, Manager of Field Circulation, chatted about experiences of out-of-States men.

Far from typical were the doings of several McGraw-Hill circulation people during the recent Argentina revolt in Buenos Aires. Our Al Maley and Butch Schenker were lunching on the eighth floor of Gath & Chaves, two blocks from bomb zero, when all hell broke loose. Al writes, "Had we figured bombs would be missing their target at the Plaza by several hundred yards and machine-gun bullets would be ricocheting around the Plaza and nearby streets, we might have proceeded differently. But we sensed the fact that something might stand between the food spread before us and our next meal. So we finished eating, perhaps at an accelerated pace."

After working their way back through shouting crowds to the McGraw-Hill office, the next move was quite obvious and in but one direction: to the city's outskirts. Scooping important papers and cash into a brief case, both headed for quieter, safer ground.

A sudden bombing seldom finds its way into a circulation man's workday. Following a fairly quiet life, a foreign rep is looked on as a kind of engineering missionary. He locates key people, briefs them on the vast American and foreign know-how available in the pages of McGraw-Hill magazines.

More typical experience in a circulation man's life would be Gil Fraser's trip into Canada's Northwest Territory (now the Mackenzie District). The run from Edmonton to the uranium area in Port Radium is about 1000 miles: two plane hops and a boat trip. Gil makes a point that only top-grade uranium concentrate is shipped out. He writes, "Folks here play baseball on a diamond composed of uranium tailings, gossiped to be worth over $1,000,000. Largest diesel plant in the area is here—six units producing over 2000 hp. Ore for one of the atom bombs dropped on Japan came from this mine."

Power readers are concentrated in the United States and Canada, with a light sprinkling of foreign subscribers. But even distant areas on the American continent are not overlooked in our aim to bring current technical information to key engineers. A case in point is found in a circulation man's report from another part of the Canadian Northwest where auto travel is reserved for the truly hardy souls. Our Morrie Marksbury shredded two tires in the run from Dawson, Yukon Territory, to Fairbanks, Alaska. He took over 4½ hours to cover only the first 60 miles of his journey, and that was in June!

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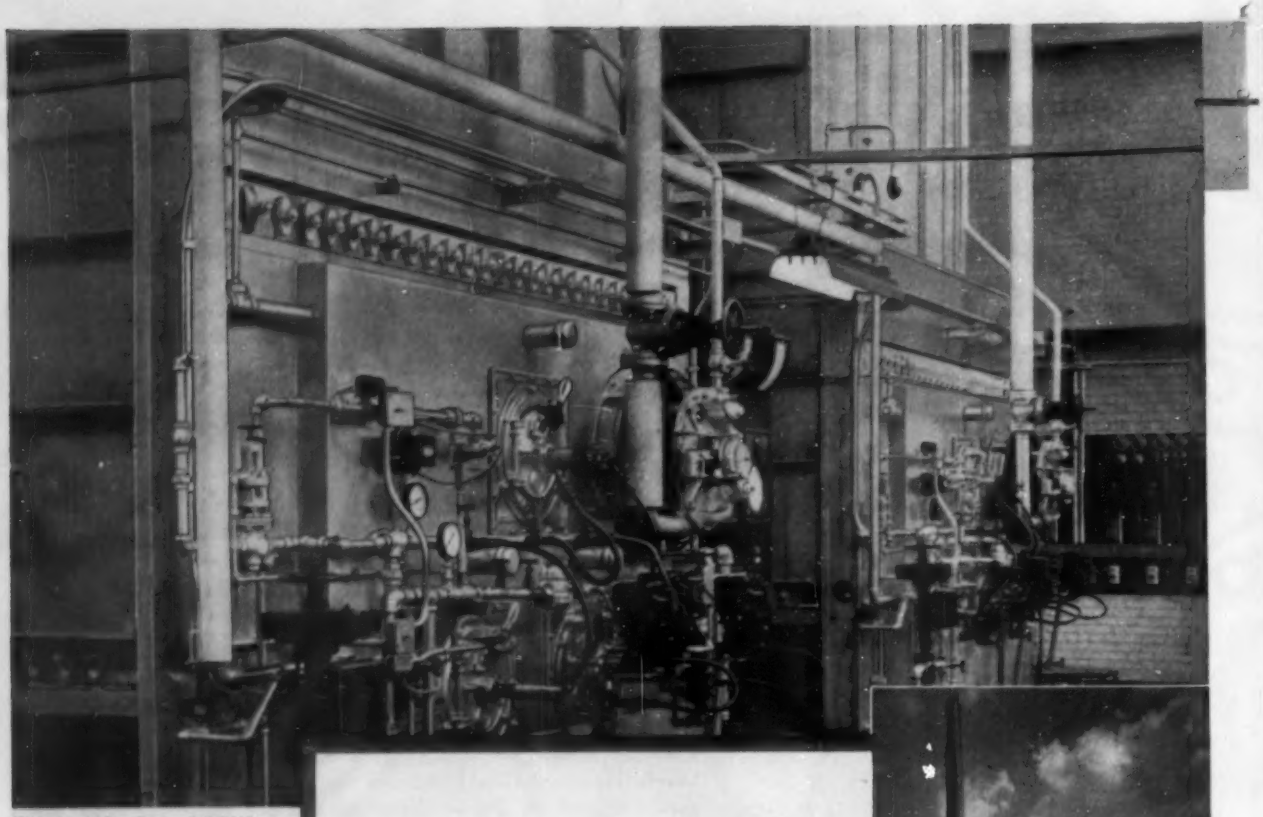
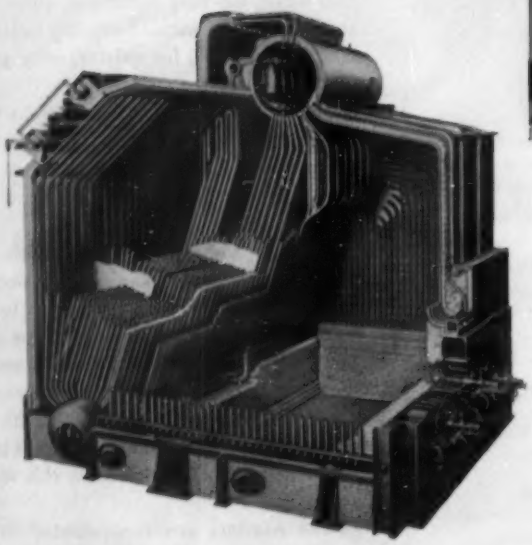


This installation of B&W Integral-Furnace Boilers at the Chicago plant of Wesson Oil Co. is producing "cheap" steam through efficient operation and with minimum maintenance and labor.



Sectional view of typical oil-fired B&W Integral-Furnace Boiler similar to units in service at Wesson Oil plant. Suitable for oil, gas, and coal firing the Integral-Furnace Boiler family is available in steam capacities to 350,000 lb per hr. Cost saving features covered in bulletins available on request.

G-633

on the record . . .

2 B&W Integral-Furnace Boilers at Wesson Oil's New Chicago Plant provide

PERFORMANCE *with* ECONOMY

Despite unusually severe operating conditions, with frequent and wide load swings at odd times and without warning, two B&W Integral-Furnace Boilers at this plant are providing steam efficiently and economically, to the complete satisfaction of company engineers. And performance such as this is being duplicated in plant after plant across the country—both new and old—where operational savings over a relatively few years are proving sufficient to cancel the initial investments.

Southern Cotton Oil Company—processor of the popular Wesson Oil and hydrogenated shortening—needed a fully-reliable steam supply for its new Chicago plant, with "push-button" operation wherever practical. To meet these requirements, they chose long-life, automatically controlled B&W Integral-Furnace Boilers. Oil-fired at present, they can also burn gas and may be converted readily to coal firing if conditions warrant. Each unit has a steam capacity of 40,000 lb per hr at pressures to 250 psi. They supply steam for year 'round processing and carry the additional load for heating during winter months.

An efficient system of automatic controls makes operation of these B&W Integral-Furnace Boilers quite simple. This emphasis on automatic operation has "paid off" at the new plant, which is producing steam with minimum maintenance and operating labor. These advantages are, of course, reflected in the plant's low overall steam cost.

Layout of the boilers and plant was under the direct supervision of Mr. L. C. Haskell, vice president of Southern Cotton Oil, working with the company's consulting engineers, The Austin Company, who designed and constructed the building. B&W erected the boilers, then ran complete operational tests before turning them over to Southern Cotton Oil Company as satisfactory, operating units. We shall be glad to discuss details of any unit in the B&W "family" of Integral-Furnace Boilers in terms of your steam requirements. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd St., New York 17, N. Y.

Service-Proved

COST SAVING FEATURES

of B&W Integral-Furnace Boilers for Steam Requirements from 2900 to 350,000 Lb Per Hr.

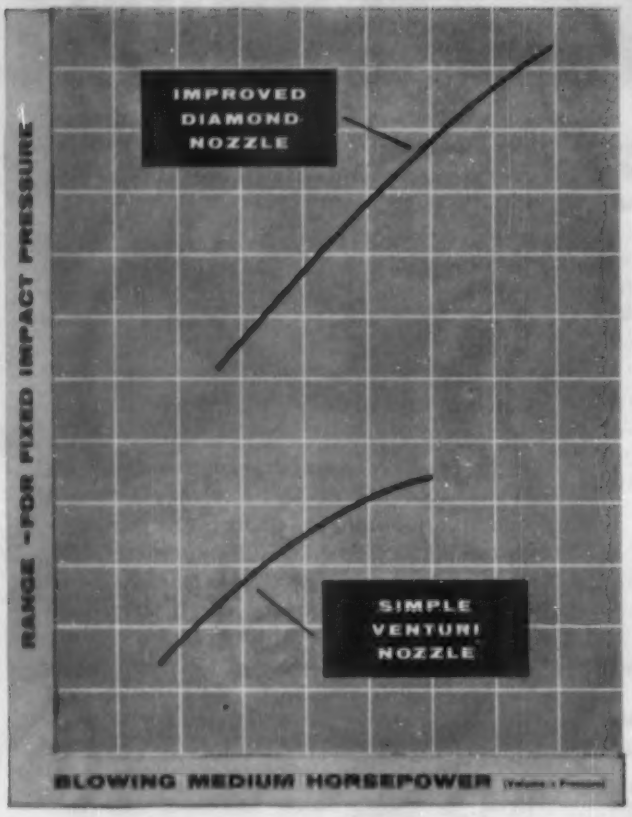
- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler-water concentration
- Quick response to wide and heavy load swings
- Easy to inspect and clean
- High availability with least attention

BABCOCK & WILCOX

BOILER DIVISION

GETTING BACK TO FUNDAMENTALS:

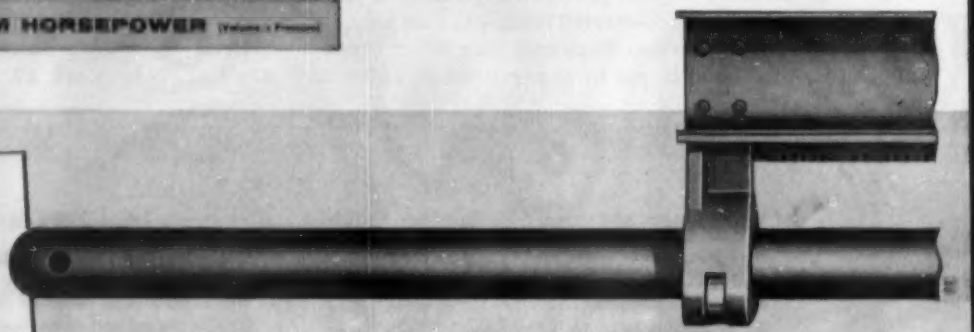
Efficient BOILER CLEANING



The blower nozzle has the job of converting steam or air pressure into velocity which, in turn, produces impact pressure at the surface to be cleaned. Effective cleaning depends on this impact pressure. A well-designed nozzle will convert much more efficiently . . . doing a better cleaning job with less steam or air.

During the past several years Diamond has conducted intensive research into nozzle design to find the ultimate in efficiency. (More than 50 designs were tested.) It was soon found that nozzle design responds to perfection of detail. Among the details studied were: (1) divergence angle of nozzle, (2) inlet radius as a function of throat diameter, (3) length-diameter ratio of nozzle, (4) area ratio of lance to nozzle throat, and (5) nozzle approach conditions. A product of this research is our new "Type A" Nozzle for Model IK Blowers. The curves at the left show how much more efficient it is than the simple venturi nozzle. The result is improved cleaning at substantially lower energy cost.

YOU CLEAN BOILERS *BETTER* and at *LOWER COST* with DIAMOND BLOWERS

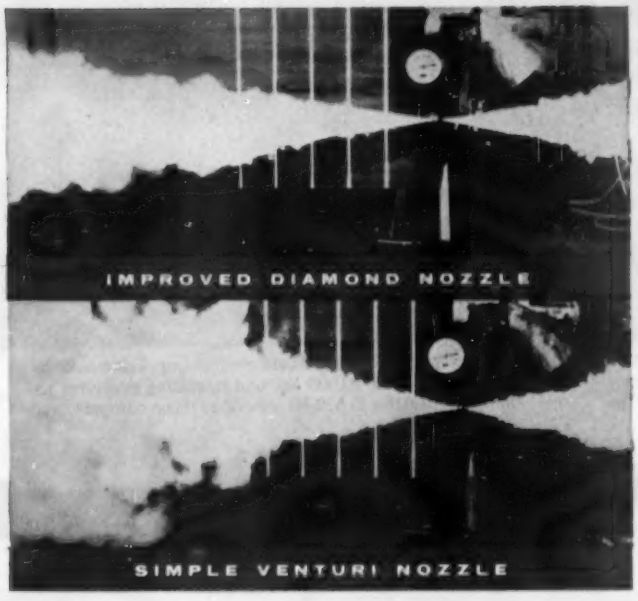


DIAMOND MODEL IK LONG RETRACTING BLOWER

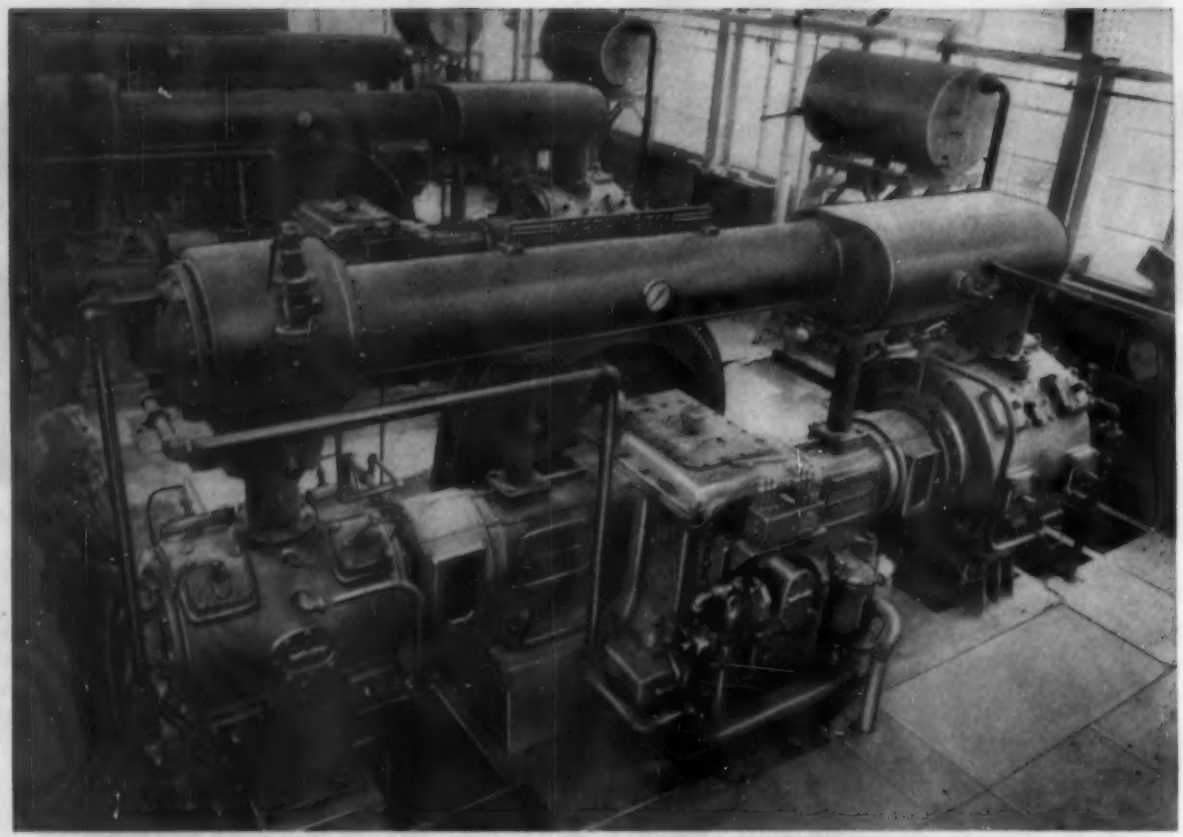
A SINGLE motor (air or electric) both rotates and propels the long lance tube through a simple and rugged gear system. Only one set of motor elements, one set of control elements and one set of power supply facilities to operate and maintain. Flow control of blowing medium (steam or air) is automatic, positive and accurate by means of a simple, mechanically operated valve. This valve is poppet type and has adjustable pressure control. The improved nozzle design coupled with the close helical cleaning pattern assures maximum effectiveness for each blower operating cycle. For additional advantages, write for Bulletin 1080 U.

Starts at the BLOWER NOZZLE

Photograph of section through Diamond "Type A" Nozzle.

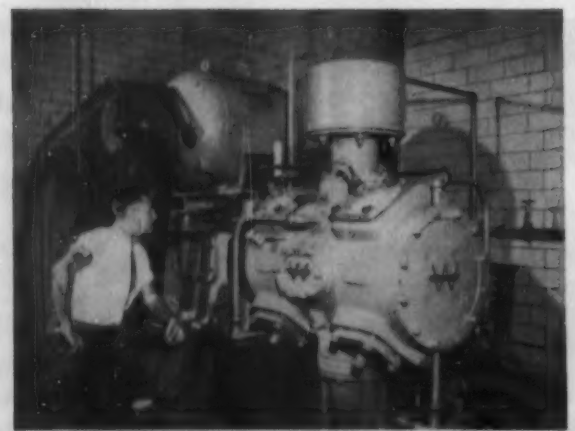


The two photographs at the left show the Improved Diamond Nozzle and the simple venturi nozzle under identical test conditions. These tests proved that the effective range of the new Diamond nozzle is substantially greater. Also that at the same range, the impact pressure of the Improved Diamond Nozzle is much higher than for the simple nozzle. For equal cleaning ability, the higher efficiency of the new Diamond nozzle requires a much lower blowing medium pressure.

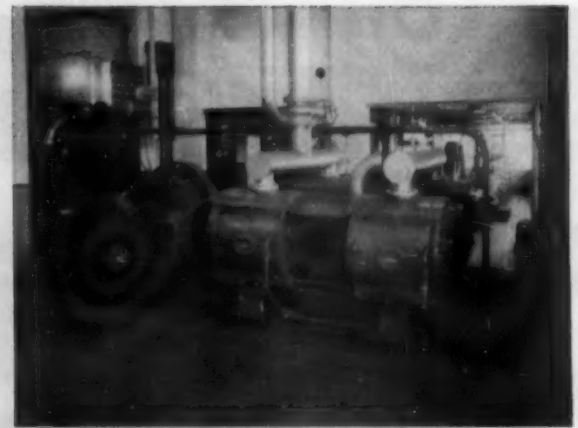


BALANCED OPPOSED COMPRESSOR, TYPE BDC. This two-cylinder, two-stage double acting unit, driven by a direct-connected synchronous motor, compresses air to 110 psi with capacity of 2400 cfm. These compressors are available in sizes from 300 to 10,000 hp, and operating pressures to 35,000 psig. Bulletin L-679-B1 describes these compressors.

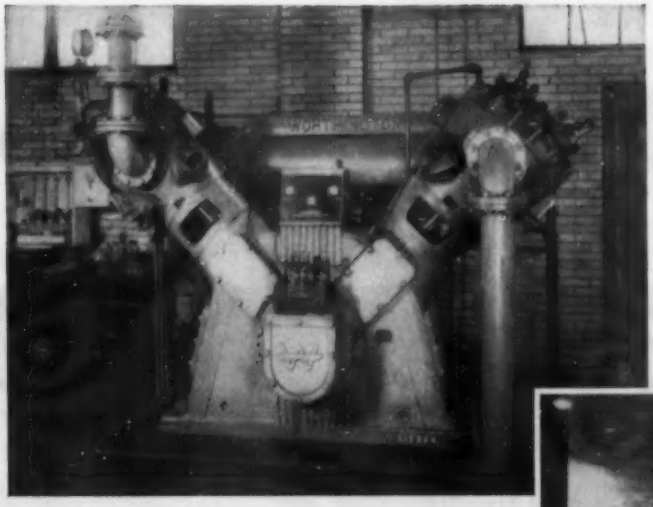
See YOUR next



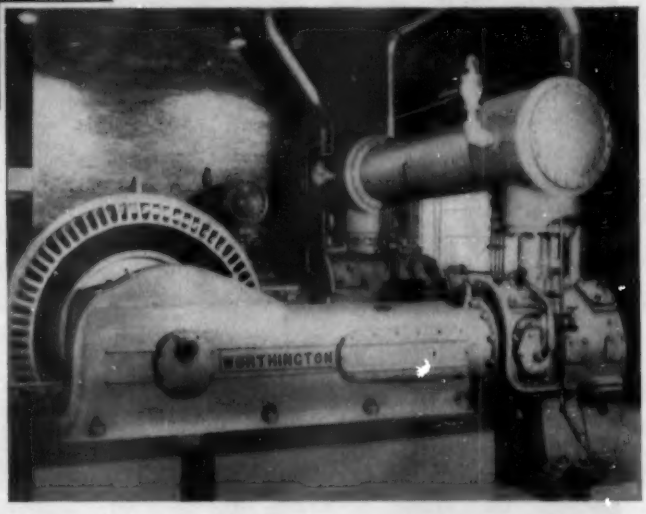
TANDEM TWO-STAGE COMPRESSOR, TYPE HB-2. This unit supplies compressed air at an Eastern manufacturing plant. Similar compressors, supplying pressures between 150 and 500 psig, are available with motor drive; Type HB-2 shown, and steam drive, Type HS-2. Double row tapered roller bearings, and automatic self-oiling frames help insure long trouble-free operation. Described fully in Bulletin L-655-B1B.



DUPLEX TWO-STAGE VACUUM PUMP, TYPE DCV-2. This "compressor in reverse," driven by 175-hp direct connected motor, produces 1-inch Hg absolute pressure for use in chemical gas service. This dry vacuum pump features valves in heads for low clearance and high volumetric efficiency, important here where compression *ratio* is high though absolute pressure is low. Bulletin L-600-B9-4 tells how to select a vacuum pump.



SINGLE-STAGE ANGLE COMPRESSOR, TYPE YC. This compressor, in Midwest rubber plant, is driven by flange-mounted 125-hp motor. Angle design results in most compact compressor for its capacity. Available in standard sizes, two-stage, up to 200 hp, 80 to 125 psig, and in larger sizes in similar type DYC. For more information on these compressors, write for Bulletins L-676-B1A and XL-677-B5.



HORIZONTAL DUPLEX COMPRESSOR, TYPE DC-2. This compressor does heavy-duty service in an automobile accessory plant. Its powered with a 500-hp direct-connected motor. Sizes from 250 to 3000 hp find application in mining, steel, glass, ship-building, chemical and oil industries and manufacturing. These compressors are completely described in our Bulletin L-675-B1B.

compressor here?

Whether you can see it or not, one thing's certain. Whatever size or type of compressor you need, you don't have to look any further than Worthington's complete line. Here's why:

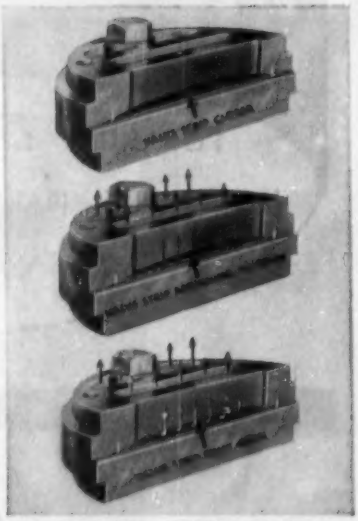
Today, Worthington compressors supply industry with air and gas pressures ranging from 0.25 psia to 35,000 psig, at powers up to 10,000 hp.

The practical "know-how" we've accumulated in these installations and the training and skill of our engineering staff are available to solve your industrial compressor problem.

Every size and type of compressor — Y, single and duplex horizontal, balanced opposed — is available in the standard Worthington line. And there's a type for every practical drive——electric motor, gas or diesel engine, steam turbine, or steam engine.

What's more, you gain by the undivided responsibility Worthington takes for integrating the compressor with auxiliary equipment, from suction filter to aftercooler and receiver.

Get complete information on these compressors. Write Worthington Corporation, Compressor Division, Section K.5.3, Buffalo 5, New York. K.5.3



FAMOUS FAST-OPERATING FEATHER® VALVE standard on Worthington compressors.

WORTHINGTON

Only Worthington Compressors give you Feather Valve Performance

Y-Types • Balanced Angle • Horizontal • Portable • Radial • Gas Engine Compressors

How to

FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

In the Nela Park central heating plant of General Electric Company, Bailey Meter Control insures efficient use of fuel. It enables operators to run these 18,000 lb per hour 125 psi spreader stoker-fired boilers under optimum conditions at all times.

Save Fuel

★ The productive energy produced by a unit of fuel depends on the way you put it to work in your boiler. How much heat energy you actually get depends upon the performance of your steam plant equipment.

That's where Bailey Controls can help. With a Bailey-engineered control system, you can count on a higher output of available energy per unit of fuel. Here's why:

1. Complete Range of Equipment—fully co-ordinated

You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, as might be the case if he had only a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control *systems*.

2. Engineering Service—backed by experience

No other manufacturer of instruments and controls can offer as broad an experience based on succesful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you

Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum travel-time and expense.

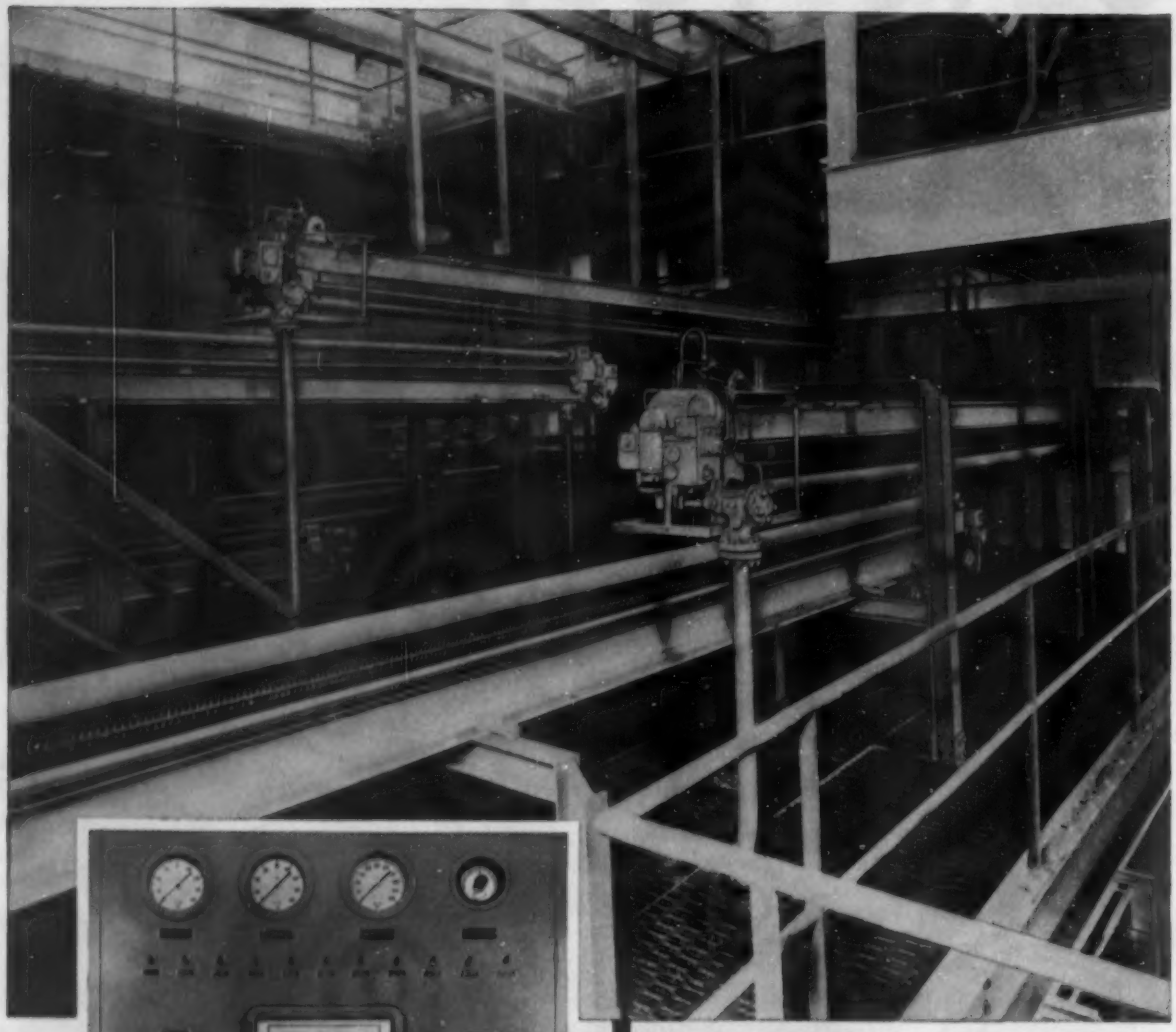
For greater fuel savings, less outage, and safer working conditions you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record.

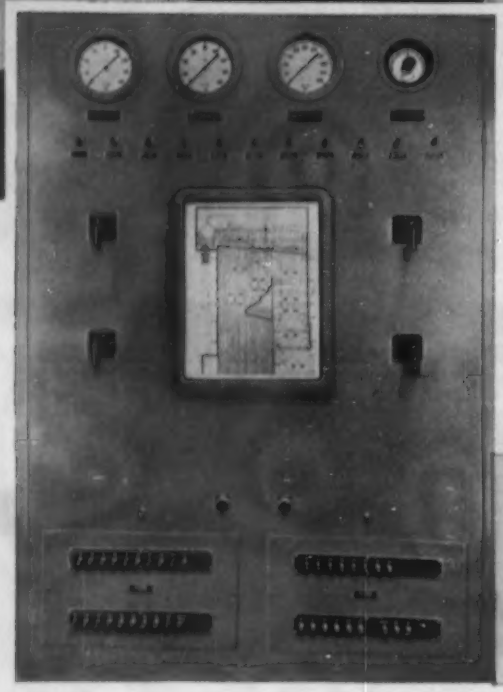
A-117-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

Right Side Up





LOOK CLOSELY, and you'll see that these Vulcan Long Retracts at St. Clair Power Plant are mounted both right side up and upside down in order to nest them together in minimum aisle space. This flexibility is one of the big advantages of Vulcan Long Retracts. Long Retracts and the Vulcan Wall Deslaggers shown in the smaller photo, right, are operated automatically and remotely from the boiler control room.

A GLANCE AT THIS PANEL tells the operator which blowers are operating. He can keep track of the entire blowing sequence by watching indicating lights on the boiler diagram. Four B&W coal-fired steam generators are installed at St. Clair Power Plant. Each is rated at 1,070,000 pph, at 2050 psig and 1000 F. Vulcan Automatic-Sequential Soot Blowing is used on all four units.

and Upside Down

Vulcan Soot Blowers clean efficiently at ST. CLAIR POWER PLANT Detroit Edison Company

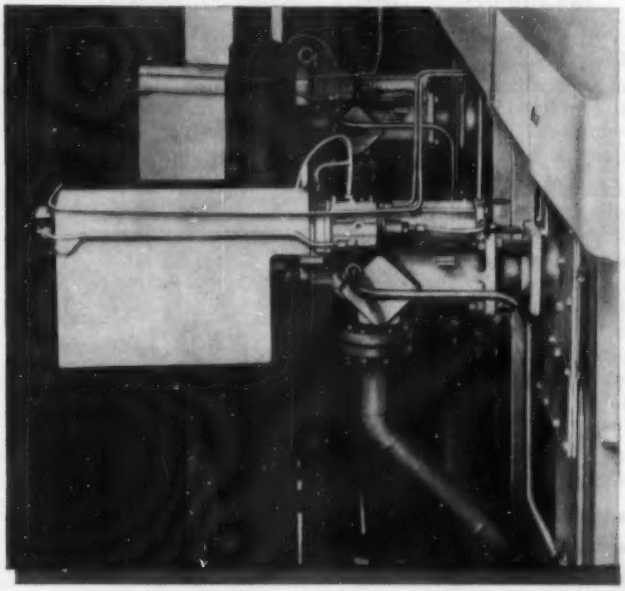
TAKE A LOOK at the big picture. Have you ever seen soot blowers nested so neatly together in such a small space? Have you ever before seen soot blowers operating upside down? These are Vulcan Long Retracts.

Vulcan Long Retracts save space outside the boiler, and require little space *inside* the boiler. The small-diameter lance fits easily into a pass with only *four inches clearance.*

Dual-motor drive on these Vulcans—one motor for traversing, one for rotating the lance—assures optimum cleaning. The high power cleaning jet takes a different path each time it operates . . . therefore, cleans *all* surfaces *uniformly.*

These Vulcans are part of a complete Vulcan Automatic-Sequential Soot Blowing System at St. Clair Power Plant. All blowing is automatic. Just push a button, and the blowers operate in sequence, each for the proper length of time for thorough cleaning. This automatic system saves time, saves labor . . . and it is *simple.*

If you need manual, semi-automatic, or completely automatic soot blowing for large, medium-size, or small boilers, write for complete facts.



COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE 4, PENNSYLVANIA

COPES VULCAN

Soot Blowing, Boiler Feed Water Regulation, Combustion Control, Complete Boiler Control from one reliable source . . .

today's most complete *advanced design*

- **863 Models** in three Basic Pressure Groups.
- **Capacities** from 2 cc. per hour to 15,000 gal. per hour.
- **Pressures** to 50,000 psi.
- **Mediums Handled.** Any liquid that will flow to the Pump—clear free-flowing, viscous, tarry materials and slurries—corrosive mediums such as acids, alkalies, salts, oxidizing and reducing agents, etc.
- **Capacity Control**—manual or automatic for proportioning in relation to temperature, time, flow, pH value, liquid level, pressure, color, conductivity or any other meterable factor.
- **Metering Accuracy** to two-tenths of one percent with automatic control mechanisms.

Now, no matter what your chemical proportioning problem—you will find the answer at PHILADELPHIA PUMP, "headquarters" for the most complete line of Controlled Capacity Pumps.

Advanced Design Offers Savings In First Cost and Maintenance

Pump users actually wrote the specifications for PHILADELPHIA PUMPS. For their design is the result of an industry-wide survey of pump users' practical experience on "what is wrong with the proportioning pumps you are using."

Simplification and standardization of basic features, and more efficient production methods, have answered the first complaint—High First Cost. Model for model, PHILADELPHIA PUMPS are lower in price.

Prevalent points of failure—cross-heads, connecting rod bearings, pressed valve seats, packing, etc.—have been corrected through advanced design and better materials of construction.

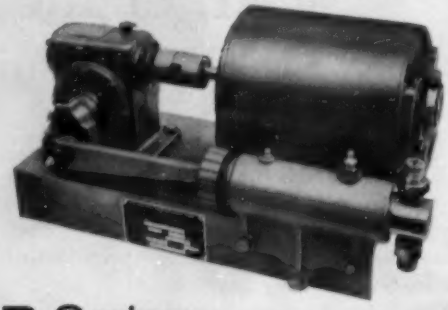
High Maintenance Costs—excessive down time and labor—have been eliminated by a design which permits the removal of all moving parts and packing through the oversize cross-head without breaking piping connections.

Proved by Years of Service In Leading Plants

Repeat orders testify to user satisfaction, and it is significant that engineers who know pumps best, men who purchase quantities of them annually for some of the largest plants—prefer PHILADELPHIA PUMPS.

It will pay you to investigate. Write for catalog.

Pressures to **800** psi

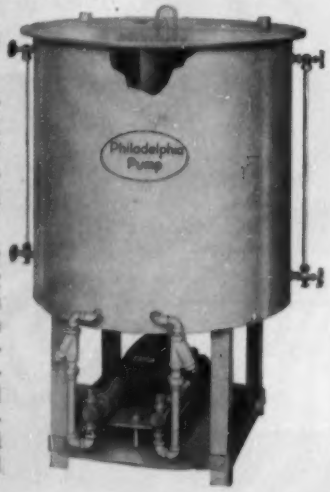


LP Series

The Phila-Feeder controlled capacity Proportioning Pump—a low cost, high quality pump popular for feeding water treating chemicals into steam boilers. Made in simplex and duplex types for maximum capacity to 18 gph. Adaptable to manual or automatic control.

Packaged Chemical Feed Units

PHILADELPHIA PUMP offers many standard and special designs of self-contained Units to meet all chemical feed requirements.



Unit illustrated is for feeding water treating chemicals. It comprises welded steel storage tank, Phila-Feeder duplex pump and all necessary auxiliaries and piping ready to connect to chemical feed piping and electrical circuits.

Other special Chemical Feed Units developed by PHILADELPHIA PUMP include:

- Oil Well Chemical Treating Systems
- Natural Gas Odorizing Units
- Special Chemical Mixing & Proportioning Units

• *Sales Engineers in principal industrial centers in the United States, Canada, Mexico, and abroad.*

PHILADELPHIA

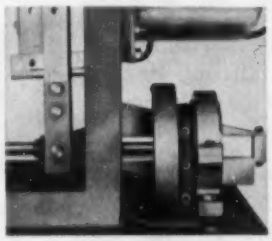
line of proportioning pumps

Pressures to **1500** psi

S Series

Made in simplex and duplex types for maximum capacity to 3300 gph. The standard proportioning pumps for most Processing Industry requirements and for treating of boiler water, municipal and industrial water, and sewage.

The pump illustrated is equipped with rocker-arm micro-adjustment of pump capacity while running.



The PHILATROL Automatic Control

This patented control mechanism for exceedingly accurate proportioning in relation to any meterable factor, adjusts piston stroke and hence pump capacity in response to manual, hydraulic, pneumatic or electrical motivation. It permits continuous stepless adjustment from zero to maximum and eliminates the "hunting" characteristics of other mechanisms with coarser adjustments.

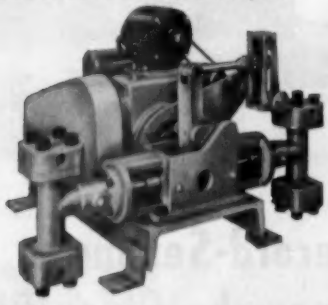
Illustrated is Philatrol Mechanism installed with air actuator on PHILADELPHIA PUMP used in gas odorizing. This pump has maintained metering accuracy within plus or minus two-tenths of one percent.

The UNI-FEEDER Automatic Control

Uni-Feeder single-revolution-clutch operated PHILADELPHIA PUMPS inject one or as many as 72 or more measured slugs of fluid per minute according to a time cycle or flow, color, concentration, or any other meterable factor.

Uni-Feeder Pumps are available with minimum capacities from .000093 gallons to maximum capacities of 27 gallons per minute.

Pressures to **50,000** psi



HP Series

These PHILADELPHIA PUMPS, designed for higher viscosities and pressures, are available in simplex, duplex and quadruplex types and in capacities from 2 cc. to 15,000 gph.

Like all PHILADELPHIA PUMPS, they are adaptable to both manual and automatic control of capacity.

The design of these pumps offers mechanical advantages which permit reduction in horsepower normally required by as much as 30 percent.

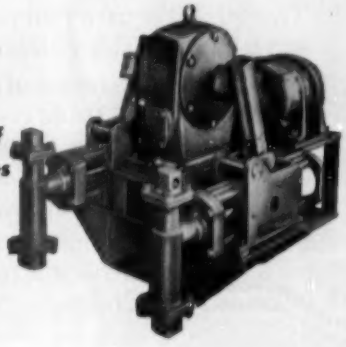
Differential Pressure Pumps

PHILADELPHIA PUMPS of the HP Series also offer a design feature which permits them to utilize the energy incorporated in any suction pressure to decrease the amount of horsepower required to produce the desired discharge pressure.

For example, if suction pressure is 2000 psi and discharge pressure is 3000 psi, the pump requires powering only for the differential pressure of 1000 psi, plus a small addition for friction losses. Consequently, great savings in first cost (motor, gear reducer, etc.) and operating cost can be effected.

See Our Exhibit at the 25th Exposition of Chemical Industries

December 5-9 1955



PUMP AND MACHINERY COMPANY

PHILADELPHIA • PENNSYLVANIA

SUBSIDIARY OF AMERICAN METER COMPANY / EST. 1836

Here's

Record-Setting Kanawha River Plant Uses Allis-Chalmers Condensers

'54 tops record-setting '53!

The 9170 Btu per kilowatthour annual heat rate at Kanawha River Plant was lowest in the nation in 1953 according to the Federal Power Commission. In 1954 the rate was even lower . . . 9133 Btu per kilowatthour, again lowest in the nation.

That means only 7/10 of a pound of coal is required to produce a kilowatthour of electric energy at this outstanding plant.

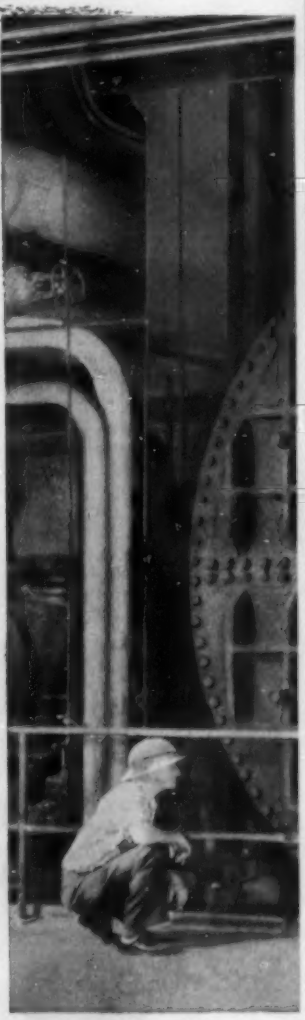
The Kanawha River Plant is owned by Appalachian Electric Power Company. It is one of 12 major power plants in the American Gas and Electric System.

Condensers are Multi-Steam Path Design

Two 90,000 square foot single-pass Allis-Chalmers condensers serve its 215,000-kw steam turbine generators.

These condensers are of multi-steam path design. This unique design makes all tubes completely effective by directing steam to even the remote sections of the condenser. The result is high vacuum, high condensate temperature and good deaeration . . . high operating efficiency.

For more information on how Allis-Chalmers multi-steam path design contributes to efficiency, contact your nearby A-C office or Allis-Chalmers, Milwaukee 1, Wisconsin. A-4772

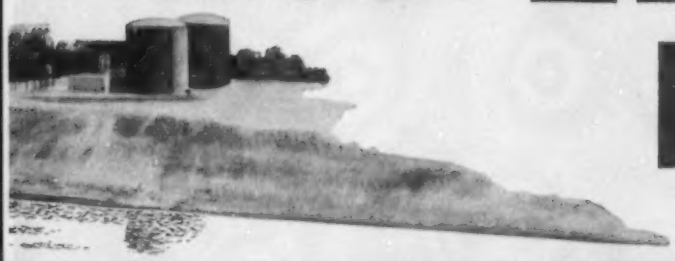


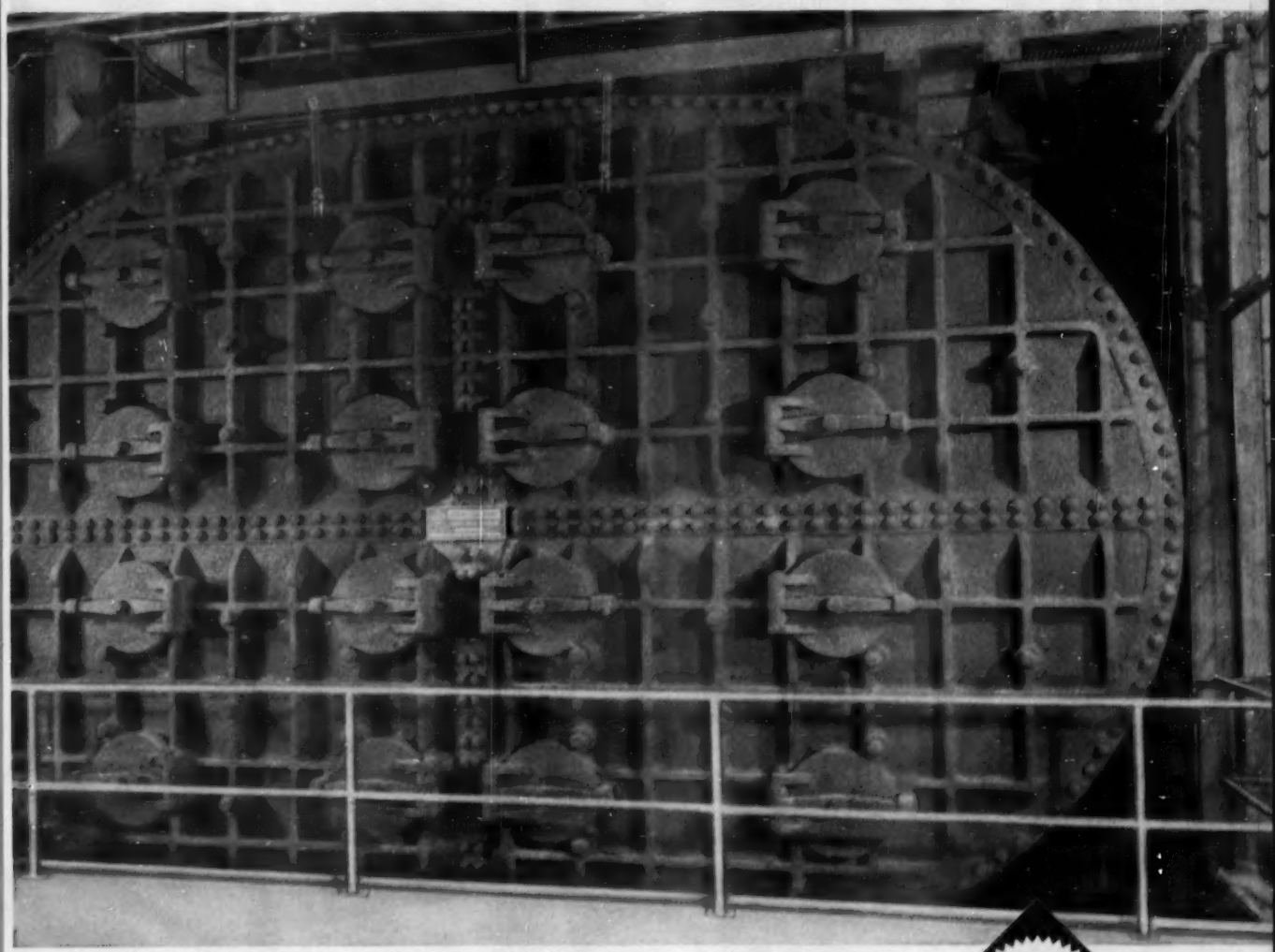
A Size and Type for Any Need

Round Oval Rectangular

ALLIS-

Condenser for Most Efficient Plant





This 90,000 square foot condenser serves 215,000-kw steam turbine generator.

CHALMERS

A-C ALLIS-CHALMERS

"Maintenance needs Megger Testers
. . . as Surgery needs the X-ray"
"MEGGER"
MEGGER
Electrical Resistance Tester
MANUAL
for
Megger
Insulation Testers
JAMES G. BIDDLE CO.

Biddle*

*

The word "MEGGER" is a registered trademark. There is only ONE "MEGGER" family of electrical resistance measuring instruments . . . and in the U.S.A., the words "BIDDLE" and "MEGGER" have been synonymous with electrical resistance testing since the beginning of the century.

*Megger**

INSULATION RESISTANCE TESTERS

Standard the World Over

One of the outstanding merits of all types of Megger instruments is quality of a high order. The performance and endurance records which these instruments have achieved are difficult, if not impossible, to match in any type of portable testing device. For insulation resistance measurements, Megger instruments are *the recognized standard.*

AN INTEGRAL PART OF ELECTRICAL OPERATIONS EVERYWHERE

Throughout industry Megger Instruments have earned the distinction of being the most widely accepted devices for making electrical resistance measurements. They are the universally accepted instruments for preventive maintenance programs and the regular maintenance of electrical equipment. By their periodic use, and from the records of their measurements of the insulation in all important equipment, trouble may be anticipated and avoided, and production stoppages and losses reduced.

BIDDLE PRACTICAL TECHNICAL ASSISTANCE HELPS MAKE PRODUCTIVE MAINTENANCE POSSIBLE

Over forty years of experience in the field of electrical testing is represented in the manuals, bulletins, and other technical literature published by the Biddle Company. These are some of the extras you get with your purchase of a Megger Instrument. Practical engineering assistance is always available without obligation.

Want Practical Help?

A complete file has been prepared for your reference in setting up and interpreting a practical electrical testing program. Included is the 100-page Megger Insulation Testing Manual . . . a valuable addition to any electrical man's library. Check the coupon or write for File 21-P.

James G. Biddle Co.

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☐ Please send me complete electrical testing information contained in your File 21-P.

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Company_____

Address_____

City_____ Zone_____ State_____

"AUTOMATION" GIVES AUTO AS CORRECT

It was the fabulous automobile industry that popularized mass production a generation ago. Now, through the miracle of "Automation," this same industry is combining mass production with *mass precision* to produce better cars—for more people—than ever before possible.

Today, in leading plants, rough metal forgings and castings enter one battery of machines, are routed by automatic transfer devices to succeeding batteries of machines, and finally emerge as finished engine blocks, crankshafts, pistons, etc.

In one plant, for example, rough engine blocks pass at the rate of 100 an hour through 637 different machines and transfers, and come out—after some 1,000 separate machining and testing operations—finished to within tolerances of one ten-thousandth of an inch.

SOCONY MOBIL

Correct Lubrication

FIRST STEP IN CUTTING COSTS

SOCONY MOBIL OIL CO., INC., and Affiliates:
MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION
Formerly Socony-Vacuum Oil Company, Inc.

INDUSTRY DRAMATIC BOOST BOTH IN QUALITY AND QUANTITY, LUBRICATION PLAYS EVER MORE VITAL ROLE

What Automation Is . . . This linking together of machines and transfer devices to obtain high precision finish of mass-produced parts is called *"Automation."* The many devices used to achieve this marvel of mass precision stagger the imagination. Electronic, pneumatic and hydraulic equipment controls the transfer of parts from one operation to another, positions each part for accurate machining, indicates when to change cutting tools, measures and sorts parts, pin-points trouble instantly should it develop. Even testing is done electronically, with parts automatically inspected at frequent intervals and ejected from the line if out of tolerance.

Correct Lubrication Vital . . . In all this maze of complex machinery there is one common factor of ever increasing importance. This is *Correct Lubrication.* For in Automation—more than in any other manufacturing process—continuous, trouble-free operation and immediate response of every moving machine part spell the difference between success and failure. Should a single part of a single machine fail, it can bring an entire battery of machines to a standstill.

This is why so many leaders in Automation have entrusted their multi-million dollar plants to Socony Mobil—world leader in lubrication. In these plants, Socony Mobil engineers work continually with operators and machine builders through a program of Correct Lubrication to help keep production flowing smoothly—hold maintenance costs to a minimum.

Whatever *your* manufacturing process—whatever you make—you can get a similar program of Correct Lubrication started in your plant to help improve your production—cut your costs. Just call Socony Mobil.

Boiler-Burner Team Wins Seven Straight

Phillips Chemical Company orders Vogt boiler and Coppus-Dennis FANMIX burner combinations to make 1¾ million pounds of steam an hour

When a customer praises a product, that's fine. But when a customer *continually re-orders*, that's conclusive proof of user-satisfaction.

Phillips Chemical Company, Borger, Texas — producer of synthetic rubber — first installed Henry Vogt boilers with FANMIX burners back in 1943. As plant production increased, Phillips again purchased the same equipment — in 1946, and again in 1951.

Today, a total of 7 Vogt boilers equipped with Coppus-Dennis FANMIX burners provide 1,750,000 lbs. steam each hour for the production of synthetic rubber. The boilers are designed for 250,000 lbs. steam peak operation but have been operated as high as 275,000 lbs. per hour. Their performance is typical of the efficiency of boilers equipped with Coppus-Dennis FANMIX burners.

FANMIX • Better Combustion • Better Efficiency • Higher Ratings

All Coppus-Dennis FANMIX burners — for gas as well as combination gas-oil — have the exclusive FANMIX action. Their *revolving orifices* give violent mechanical mixing and agitation of gas and air, therefore causing instantaneous and complete combustion with *minimum excess air* (5% excess air is not unusual).

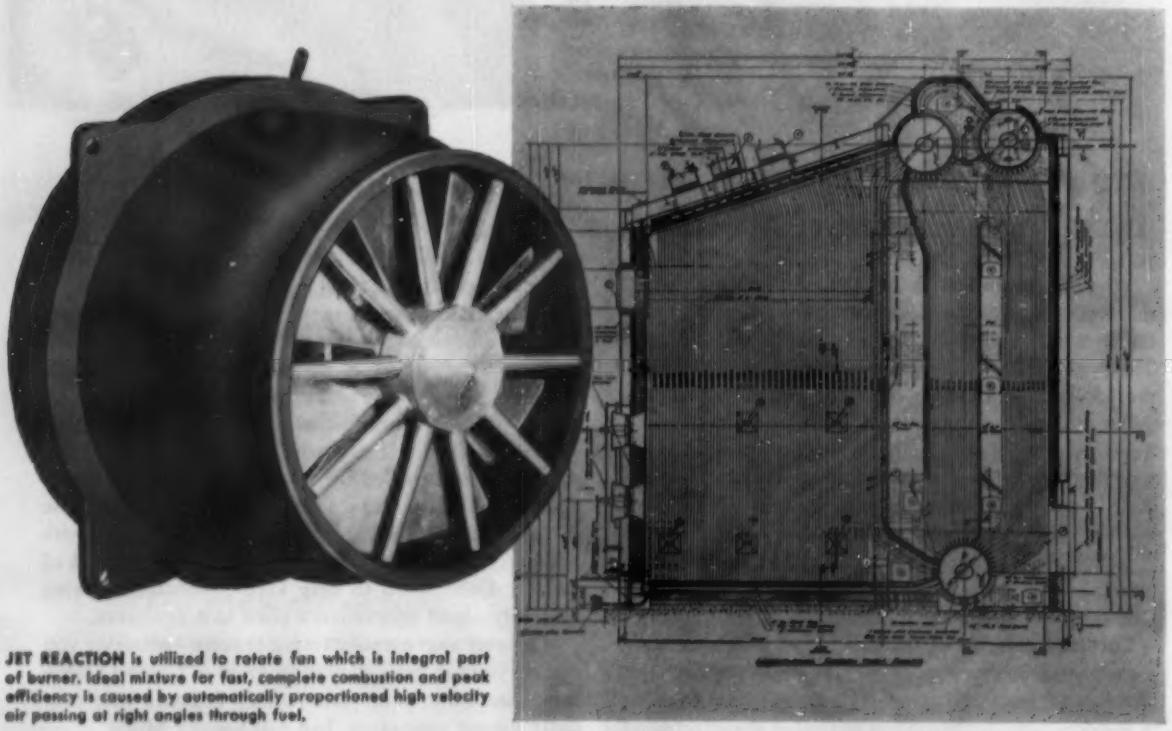
Because of this exclusive FANMIX action, furnace space is not required for mixing and *higher boiler ratings* are thus easily obtained. The burners also have a shorter flame than any other burner and will not cause flame impingement.

What's more, by incorporating a *fan* as an integral unit, FANMIX burners have *no draft loss* across the burner. As a result, increased ratings are possible regardless of draft conditions.

FANMIX action, with its quick completion of combustion, gives *lower* exit temperatures.

If you are not using Coppus-Dennis FANMIX burners in your present boiler, why not plan now to take advantage of the exclusive FANMIX action? You need no forced draft equipment, increase in stack or increase in furnace volume for FANMIX operation. And you get increased capacity. When specifying FANMIX on *new* boilers, you can plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity — and, of course, *no* forced draft equipment.

For further information, mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory* and *Mining Catalogs*.



JET REACTION is utilized to rotate fan which is integral part of burner. Ideal mixture for fast, complete combustion and peak efficiency is caused by automatically proportioned high velocity air passing at right angles through fuel.

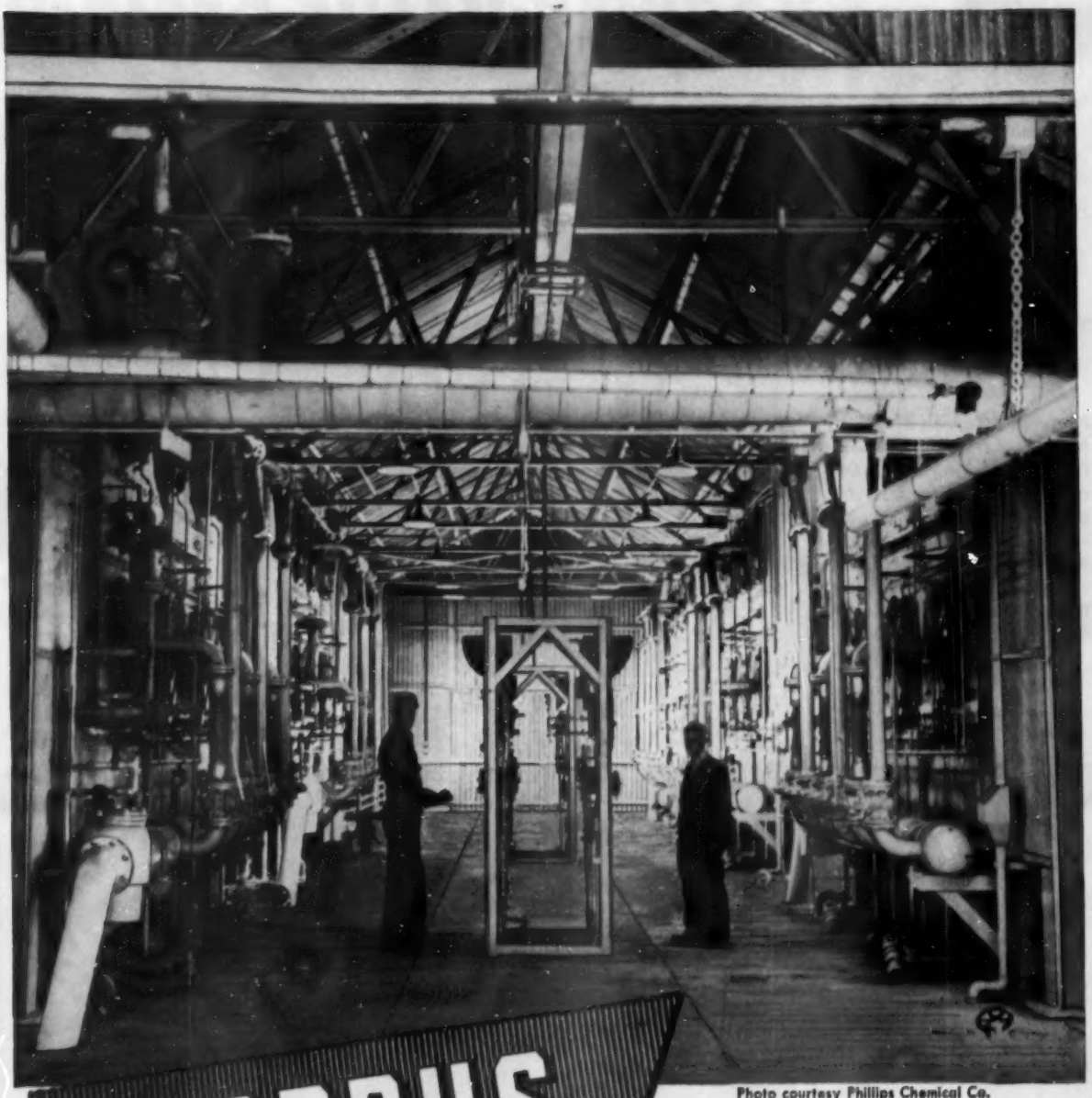


Photo courtesy Phillips Chemical Co.

HENRY VOGT BOILERS are here shown installed in the Phillips Chemical Company, Borger, Texas. Boilers use Coppus-Dennis FANMIX burners.

SEND COUPON for further information. Coppus engineers FANMIX burners to your individual requirements.

PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION
16 Park Avenue
Worcester 2, Massachusetts

Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in ☐ gas ☐ combination gas-oil.

Name.....Title.....

Company.....

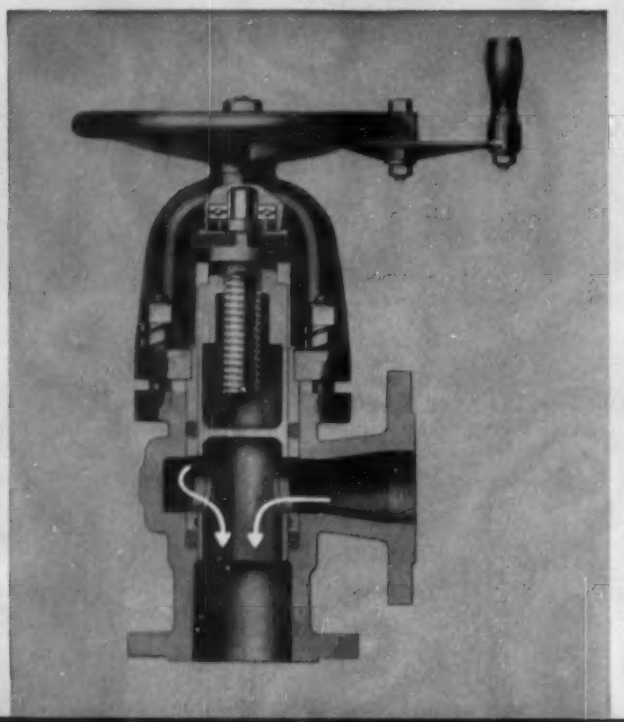
Address.....

City.....Zone.....State.....

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGH PRESSURES

USED IN OVER 15,000 BOILER PLANTS

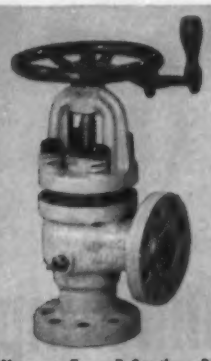
serve every boiler blow-down need

■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

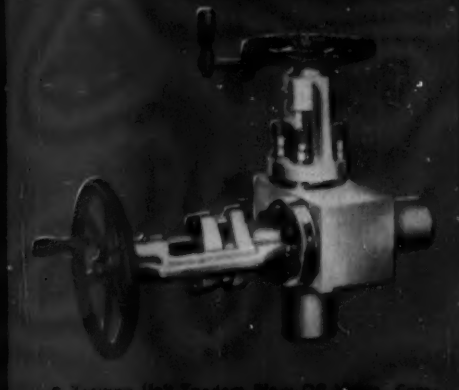
Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).



• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.

• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

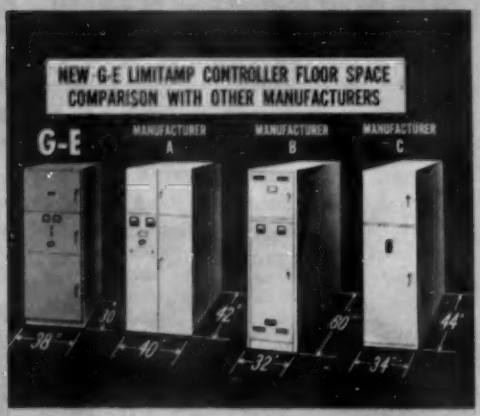


LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves



356 SQ. IN. LESS area than next smallest starter.

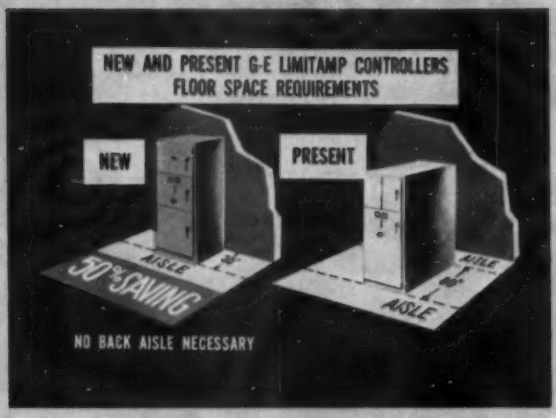
General Electric Announces . . .

NEW Limitamp*

- **Gang-operated disconnect switch on all units**
- **Entirely front connected**
- **30-inch depth**
- **Low-voltage panel hinged to swing out of enclosure**
- **Contactor rolls in or out of cabinet**

NEW DESIGN

INSTALLATION IS SIMPLIFIED. A man can easily enter enclosure to make connections.



OVER 50% SPACE SAVINGS by elimination of back-aisle.

VERSATILE INSTALLATION—units all front connected.

Control saves over 50% floor space

ENTIRELY FRONT CONNECTED, only 30 inches deep, General Electric's all-new Limitamp control offers versatility of installation. New 30-inch depth allows unit to be transported through normal size doorways, and 90-inch height includes bus compartment. Back-to-back, back-to-wall, or mounting as free standing enclosure is now possible.

IDEAL FOR HIGH-VOLTAGE MOTORS, rated 2300-4800 volts and up to 3000 h-p, the new Limitamp control may be applied to squirrel-cage, synchronous, wound-rotor, and multi-speed motors on power systems requiring high interrupting capacity for maximum short-circuit protection.

NEW CONCEPTS IN SAFETY are built into new Limitamp control. Gang-operated disconnect switch, steel barriers between all compartments, enclosed bus compartment and co-ordination of starter assure you of safer high-voltage motor control.

G.E. LIMITAMP STARTERS are co-ordinated to provide maximum protection for equipment and personnel. Co-ordinated circuit components guard against needless fuse blowing, give running overload protection and provide maximum safe-guard against short-circuit damage for starter and equipment.

FOR COMPLETE APPLICATION ENGINEERING service contact your nearest G-E Apparatus Sales office. Write for Bulletin GEA-6331, Section 781-12, General Electric Co., Schenectady 5, New York.

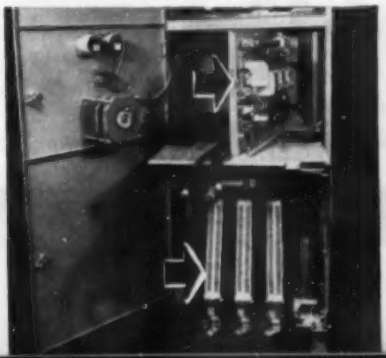
*Trade-mark of General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC

SIMPLIFIES INSTALLATION AND MAINTENANCE

MAINTENANCE IS EASY. Low-voltage panel swings out, contactor rolls out.



TYPE EJ-2 CURRENT-LIMITING fuses are safely, quickly replaced within seconds.

SAFE VISUAL CHECK of disconnect switch with fuse compartment door open.

CHICAGO

WILL BE THE TARGET OF INTEREST FOR POWER MEN NOV. 14-18

CHICAGO EXPOSITION of POWER & MECHANICAL ENGINEERING

CHICAGO COLISEUM NOV. 14-18

In conjunction with 75th Anniversary Meeting of ASME

YOUR OPPORTUNITY

to learn how to cut power costs

Whether it's plant modernization, expansion or maintenance you're concerned with, you'll welcome ideas that will help to reduce the cost of your power services. You'll find many of these new ideas at the CHICAGO EXPOSITION OF POWER & MECHANICAL ENGINEERING where you can personally inspect and compare the newest developments in power and allied equipment. You can talk with the technical representatives of leading manufacturers and learn how their products may be applied to reduce *your* power costs and increase production.

Under the auspices of ASME, this great concentration of engineering information is timed in conjunction with the 75th Anniversary Meeting of the Society—and only a few minutes away, in the Chicago Coliseum.

If power—it's generation or use—is of importance to your operations, PLAN NOW to attend and see how new power equipment of all kinds can go to work for you.

Write NOW for tickets for advance registration and hotel reservation applications.

Additional registration cards available on request.

Management: International Exposition Co.
480 Lexington Avenue • New York 17, N. Y.

Be sure to see the new ATOMIC POWER SECTION

CHICAGO EXPOSITION OF POWER & MECHANICAL ENGINEERING
480 Lexington Ave., New York 17, N. Y.

☐ Please send invitation for advance registration
☐ Please send application for Hotel Reservations

Name_____ Title_____

Company_____

Address_____

Type of Business_____

OPERATING CONVENIENCE AND MODERN DESIGN are features of 7500-kw turbine-generator. Note recessed dials mounted at convenient angle for reading.

New power program for Clinton Foods starts with Worthington turbine-generator

First step toward a planned new power system for Clinton Foods Inc., Clinton, Iowa, was the recent installation of a Worthington 7500-kw automatic double-extraction turbine-generator.

This modern unit, supplying 60 per cent of the plant's electrical needs, makes Clinton Foods, manufacturers of corn products, self-sufficient from a power standpoint and also cuts power costs. In addition, the turbine-generator provides steam for plant processes at two pressures: Steam at 150 psi operates steam driers and converters and, at 5 psi, evaporators and other plant equipment.

Clinton Foods, like other Worthington buyers, knows that complete reliability is built into every Worthington turbine-generator. Main reason for this reliability is the undivided responsibility that goes with every Worthington turbine-generator. Turbine and generator are designed to operate as a unit and are assembled and completely tested in the Worthington plant *before* shipment.

Why not find out more about Worthington turbine-generators? Contact your nearest Worthington district office or write Worthington Corporation, Section T.5.6, Steam Turbine Division, Wellsville, N.Y.

T.5.6

WORTHINGTON

STEAM TURBINES

Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM

Water refined here

An oil refinery uses prodigious quantities of water for boiler-feed, processing, and cooling. To meet its requirements for properly softened water, this giant refinery treats hot, raw water with AMBERLITE® cation ion exchange resins and lime. The process is efficient, economical, and yields water of "zero" hardness.

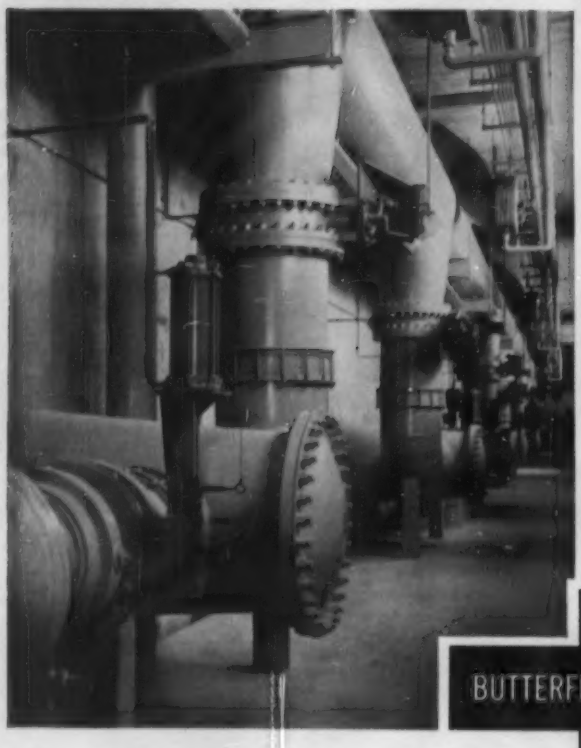
What's your water problem? Softening? Dealkalization? Deionization? Deacidification? As long as it involves the removal or replacement of dissolved salts, there's an AMBERLITE ion exchange resin ready to help you. You can call on 11 different commercially available Rohm & Haas resins in varying degrees of acidity, basicity, and porosity. Ask your equipment manufacturer or consulting engineer about ion exchange and why the resin that's *right* is AMBERLITE.

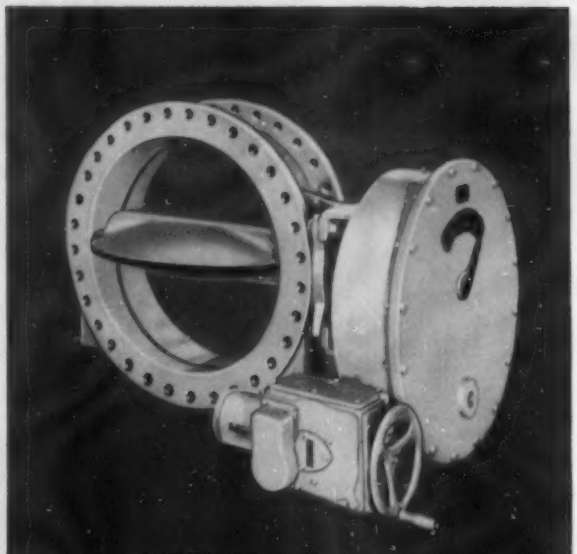
Write for "If You Use Water," 24 pages of information on treating water by ion exchange.

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA

DROP-TIGHT SHUTOFF R-S Rubber-Seated Butterfly Valves give drop-tight closure to 125 psig through wedge-type action of the disc within a one-piece rubber seat. 65 of these valves, installed as shown for service in the San Jacinto River project near Houston, gave a substantial space reduction and direct, in-place cash savings of $124,000.





FOR HIGH-PRESSURE SERVICE SMS Babbit-Seated Butterfly Valves are built to give tight shutoff and meet the rugged demands of high-pressure service. They are available for shutoff pressures up to 200 psig, and for a wide range of velocities, including open-end free discharge.

BUTTERFLY VALVES

GET POSITIVE SHUTOFF, CUT CONSTRUCTION COSTS

For high or low-pressure water service, SMS has the Butterfly Valve to give you tight shutoff and help reduce construction costs. Using SMS or R-S Butterfly Valves in place of conventional gate valves permits a much more compact piping layout, means substantial savings in the initial building costs. For full information on the complete SMS valve line – Butterfly Valves, Ball Valves and Rotovalves – see our local representative or write S. Morgan Smith Co., York, Pa.

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
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HYDRODYNAMICS

ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

SMS

S. MORGAN SMITH

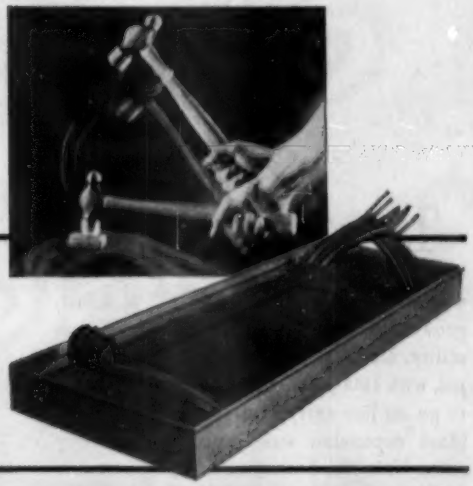
AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

NEW Silco-Flex MOTOR INSULATION

Offers These Amazing Physical Properties

Allis-Chalmers, working with Dow Corning Corporation, has developed *Silco-Flex* motor and generator insulation . . . truly new in concept . . . truly new in effectiveness.

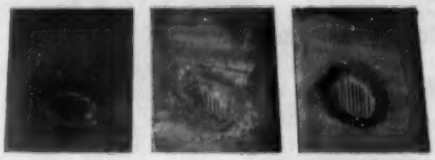
Silco-Flex insulation employs a pure silicone rubber combined with specially developed application techniques to produce an insulation unmatched by any other in use today.



● **Flexibility and Resilience** — *Silco-Flex* insulation remains flexible and resilient indefinitely. It is especially resistant to mechanical abuse and to stresses of overloading, rapid starting and stopping.

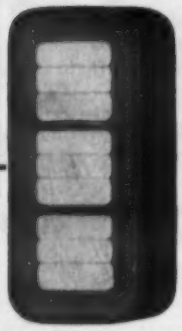
● **Moisture Resistance** — Completely sealed, *Silco-Flex* insulated coils are the most moisture-resistant commercial coils ever produced. They are production-tested while submerged in water . . . by far the most complete and searching high potential test used.

● **Abrasion Resistance** — Samples of insulation at right show effects after sandblasting with 90 grit aluminum oxide and 100 psi air for one minute. Nozzle-to-sample distance was six inches, thickness equivalent to 2300-volt insulation. Note difference in abrasion!



Silco-Flex Insulation | Polyester Mica Tape | Asphaltum Mica Tape

● **Homogeneity** — *Silco-Flex* insulation is a void-free dielectric barrier vulcanized into a unified insulating wall. It maintains its homogeneity under extremes of differential expansion and contraction due to thermal cycling.



Other Advantages include exceptionally good thermal stability and chemical inertness. *Silco-Flex* insulation is also a much better heat conductor than ordinary electrical insulating materials. Moreover, enclosures now required to protect windings from moisture and abrasion may be eliminated in many cases.

New *Silco-Flex* insulation is immediately available for all Class H form-wound coils and for Class A and B windings operating under selected service conditions. For complete information, call your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4774

Silco-Flex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

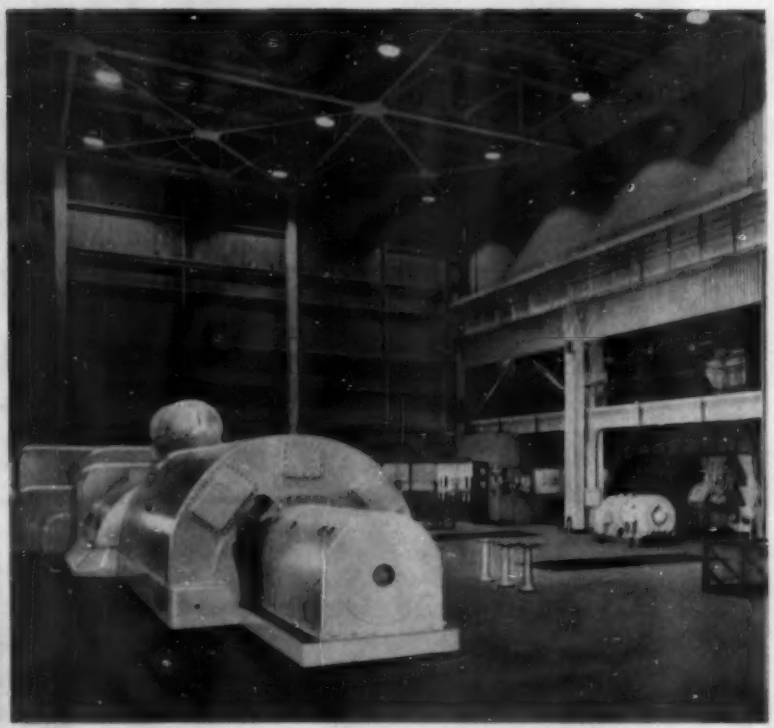
Mid-Western Utility now SIXTH FW

New 853,000 lb/hr reheat unit will bring total FW steam generating capacity on this one system to **4,338,000 POUNDS PER HOUR!**

The Foster Wheeler reheat steam generator shown in cross section at the right will serve 100,000-kw Unit No. 2 at a fast-growing steam plant of a large Mid-Western utility. Rated at 853,000 lb per hour, 1800 psi, with 1000/1000 F reheat, it is scheduled to go on line early next year. Work on this plant expansion was already under way when Unit No. 1 went on line in November 1954—served by an FW 925,000 lb/hr, 1770 psi, 1000F steam generator.

When Unit No. 2 is completed, a total of six FW steam generators, six FW surface condensers and twenty-two FW ball-mill pulverizers will be in service at the various stations of this one Utility.

Repeat orders like this are a positive expression of *confidence* in Foster Wheeler steam plant equipment—confidence that stems from previous *experience*. In major equipment of this type, customer acceptance means satisfaction with the entire job—from planning all the way through to actual operation. Whatever your requirements, it will pay you to consult *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

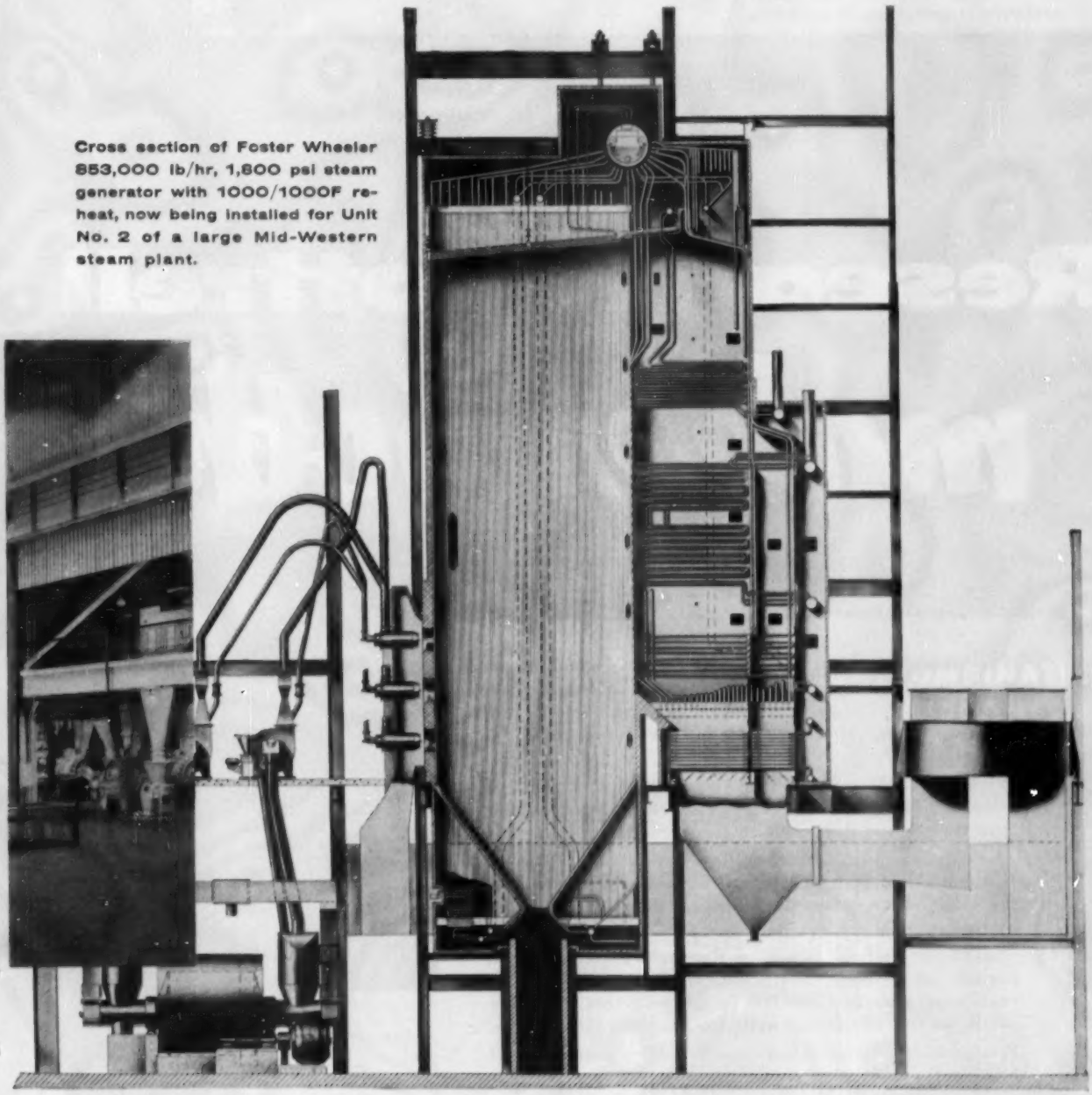


View from turbine floor of unit No. 1, put on line in Nov. 1954, showing 100,000-kw turbo-generator and exhausters of FW pulverizers for 925,000 lb/hr FW steam generator.

LONDON • NEW YORK • PARIS • ST. CATHARINES, ONT.

installing
STEAM GENERATOR

Cross section of Foster Wheeler 853,000 lb/hr, 1,800 psi steam generator with 1000/1000F reheat, now being installed for Unit No. 2 of a large Mid-Western steam plant.



FOSTER WHEELER

Research-Cottrell

makes both

The choice of a straight precipitator or a combination mechanical-electrical precipitator for fly ash recovery depends on many factors—size and composition of the fly ash, efficiency desired, space available for the equipment, initial cost, etc.

Whatever your fly ash problem you can be sure of unbiased recommendations from Research-Cottrell, because we offer both types—and have done so for many years.

The cutaway drawings on the next page show several design features of both the straight Cottrell precipitator and the combination mechanical-electrical precipitator offered by Research-Cottrell.

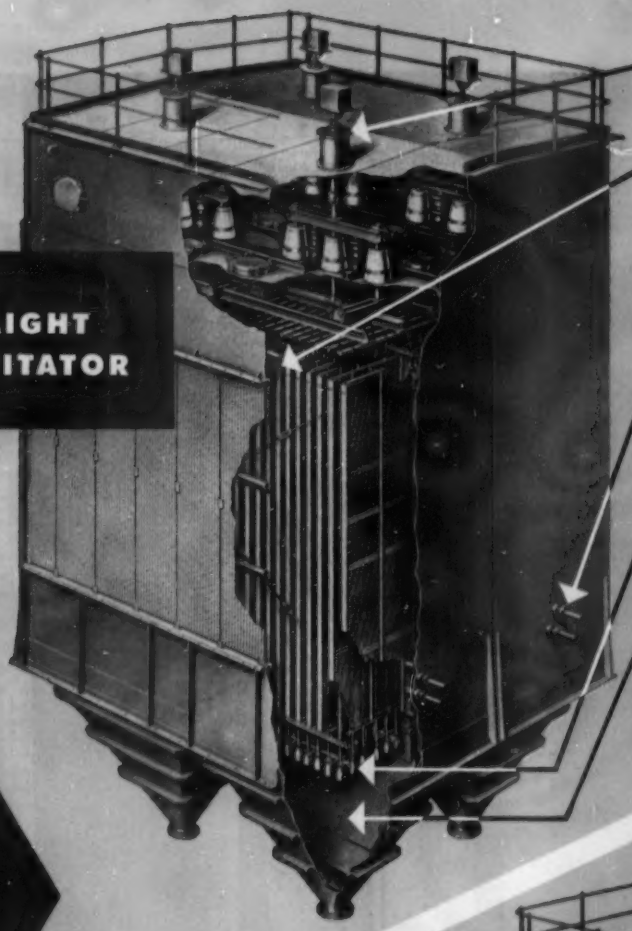
These basic designs, as well as Research-Cottrell's custom engineering of each installation, are backed by over 40 years experience and over 500 fly ash collectors. For more details on this equipment write for Bulletins GB and FA.

Precipitator is designed and constructed for many years of heavy-duty, all-weather service.

RESEARCH-COTTRELL, INC.

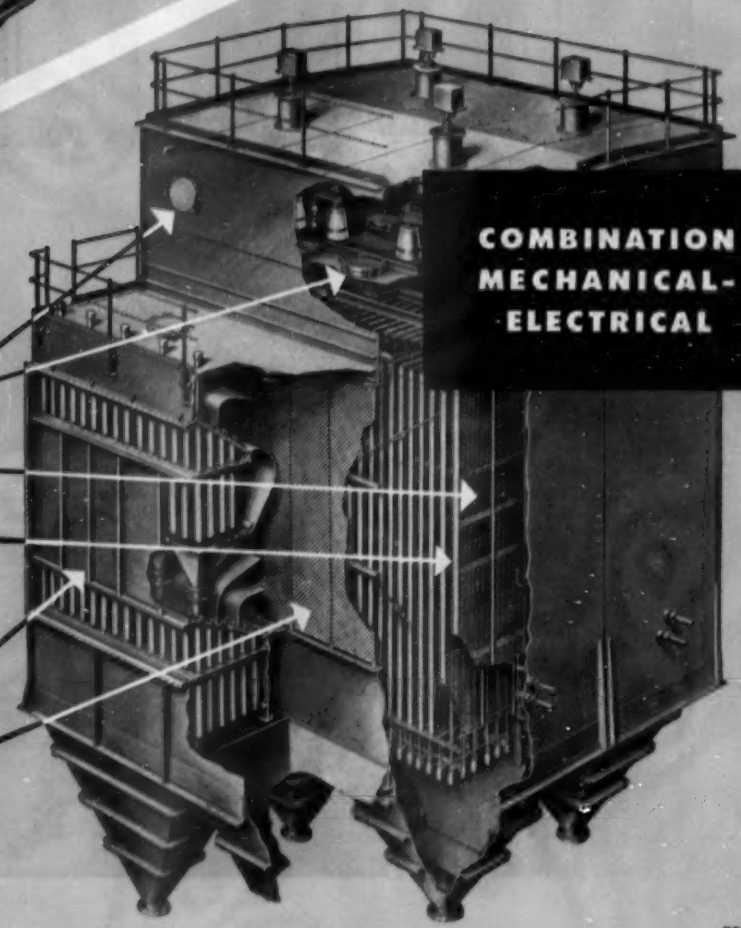
A Wholly Owned Subsidiary of Research Corporation

Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.



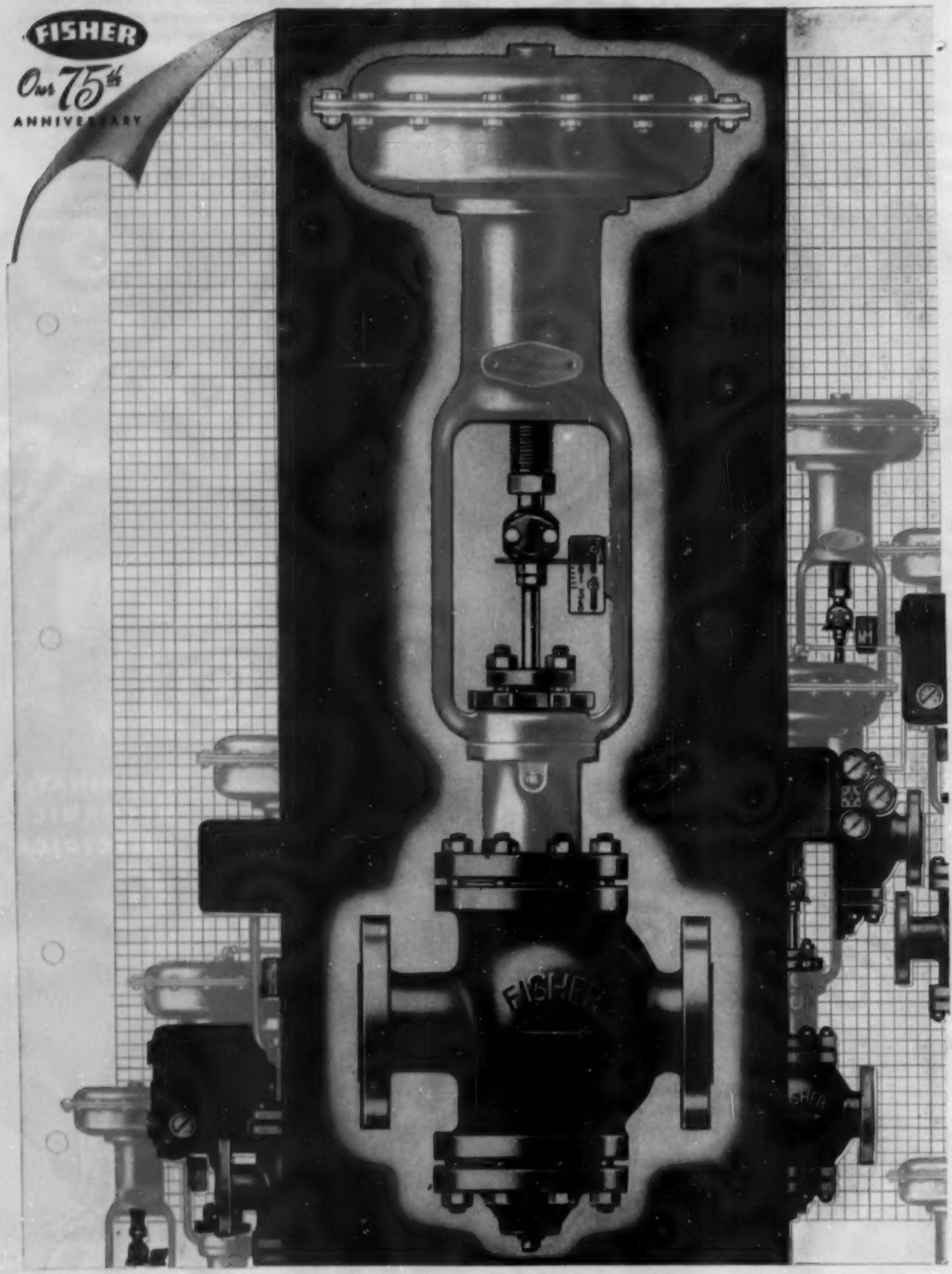
STRAIGHT PRECIPITATOR

1. Continuous, automatic discharge electrode rapping insures optimum performance.
2. Hook-type collecting electrode hangers, quickly installed, insure uniform distribution of rapper vibration throughout entire collecting surface.
3. Rapping puffs prevented by automatic and continuous cleaning of collecting electrodes with Magnetic Impulse Rapper (patents pending).
4. Plumb-bob discharge electrodes are individually weighted and positioned by a steadying frame for maximum efficiency.
5. Hopper baffle prevents gas sneakage around electrodes.



COMBINATION MECHANICAL-ELECTRICAL

6. Easy access to high tension equipment.
7. No moving parts in gas stream—minimizes maintenance.
8. End and intermediate baffles provide quiescent zones and prevent re-entrainment of collected dust.
9. Compact double-deck mechanical collector (patented) provides large capacity in a small area.
10. Double-deck mechanical collector design insures even gas distribution at precipitater inlet.


FISHER
Our 75th
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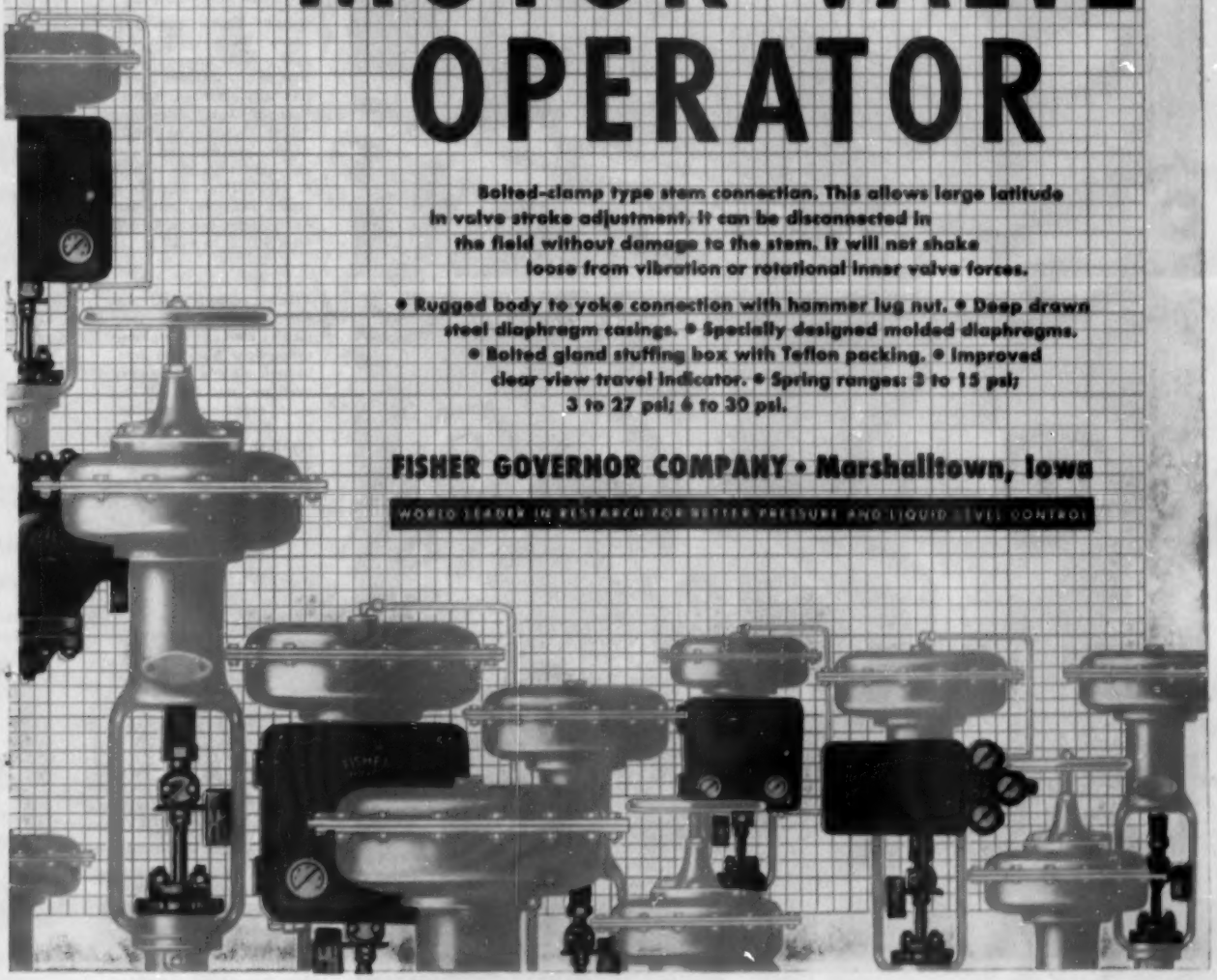
Presents An Improved

DIAPHRAGM MOTOR VALVE OPERATOR



Bolted-clamp type stem connection. This allows large latitude in valve stroke adjustment. It can be disconnected in the field without damage to the stem. It will not shake loose from vibration or rotational inner valve forces.

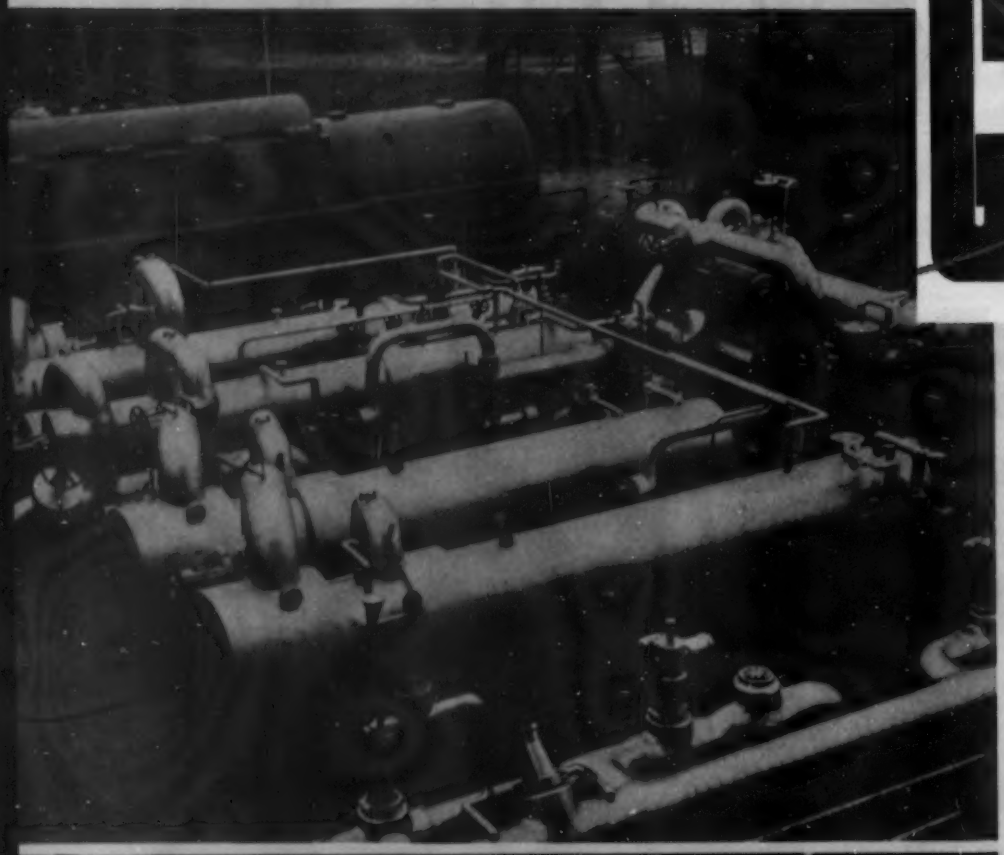
• Rugged body to yoke connection with hammer lug nut. • Deep drawn steel diaphragm casings. • Specially designed molded diaphragms. • Bolted gland stuffing box with Teflon packing. • Improved clear view travel indicator. • Spring ranges: 3 to 15 psi; 3 to 27 psi; 6 to 30 psi.

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

GPE



Griscom-Russell feed water heaters in a 125,000 KW public-utility power station; save nearly 100 tons of coal per day. Heaters handle flow of water exceeding 2000 G.P.M. at 2500 pounds pressure and steam extracted from the turbine at five different points; "train" of five units pre-heats water fed to boilers from 90° F. to 441° F.

Askania multiple fuel boiler control panel in large steel plant; maintains metered proportion between combustion air and fuels—coke oven gas and fuel oil—for most economical combustion; holds steam pressure constant through all load changes and keeps furnace pressure at a safe and predetermined value.

General Precision Laboratory's Industrial TV Camera, the "Bullet"; portable, easily operated; used to monitor and improve manufacturing processes and to view hazardous industrial operations.

The highly advanced technological products designed and manufactured by the eighteen producing companies of General Precision Equipment Corporation serve more than a dozen major industries. Products of six of these GPE Companies—Griscom-Russell, Askania, Librascope, Link, Kearfott and General Precision Laboratory—have widespread application in the processing and power industries.

Industrial Processing...and Power

The Griscom-Russell Company is one of the country's largest producers in the fields of heat exchange and water distillation. It is the pioneer in heat exchanger equipment—the key to the whole complex of modern industrial processing and power. For over seventy years, G-R equipment has been responsible for greatly increased efficiency and lowered operating costs in industry.

Askania Regulator Company for a quarter of a century has been a leading developer in the field of regulators and controls, including components and systems. Its products are widely used by the power, steel, gas and coke, mining, chemical, petroleum, glass and paper industries—wherever great reliability and accuracy are essential.

Kearfott Company, Inc.; Librascope, Incorporated; and Link Aviation, Inc. produce a wide variety of precision instruments, computers, servos and other control components for equipment and systems used throughout the power and the processing industries. Industrial television equipment manufactured by General Precision Laboratory Incorporated, the sixth GPE Company active in these fields, is playing increasingly important roles in "seeing eye" monitoring operations in these industries.

Each company in the GPE Group works in specific, highly specialized technical areas, as indicated in the chart below. Each of these companies, in addition to specializing in its particular products and fields of technical competence, has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation is achieved through GPE's basic operating policy, Coordinated Precision Technology.

In the fields of research and development, GPE Coordinated Precision Technology permits a high degree of specialization in particular areas of competence and supplements such specialization by the application of techniques in other fields, as desirable. In the field of production, it makes possible a highly flexible application of facilities. This policy has been responsible for a diversified line of precision equipment of superior design and performance, covering a wide range of both standard and special uses.

Perhaps the most conspicuous advantage of GPE Coordinated Precision Technology is that the concept and development of equipment, and of solutions to the underlying technical problems, are not restricted or distorted by traditional allegiance to specialization in a particular field. GPE coordination permits the engineers and technical personnel of each GPE Company to seek the optimum solution for the customer within the total capacities of the GPE Companies as a group.

● Manufacturing
●● Manufacturing and product development
●●● Manufacturing, product development and research
□●● Prior manufacturing, product development and research

	KEARFOTT COMPANY, INC.	INTERNATIONAL GENERAL CORPORATION	BLUMENTHAL DIVISION	GENERAL PRECISION LABORATORY INCORPORATED	THE GRISCOM-RUSSELL COMPANY	LINK AVIATION, INC.	THE WESTINGHOUSE ELECTRIC COMPANY	THE STROMBERG-CARLSON CORPORATION	A. E. HANLEY MFG. CO.	ASKANIA REGULATOR COMPANY	ARPRO CORPORATION	LIBRASCOPE, INCORPORATED
PRECISION MECHANICS, OPTICAL DEVICES, CERAMICS	●●●	●●	●●	□●●	●●	●●●	●●	●●●	●●	●●	●●	●●●
ELECTRICAL EQUIPMENT and COMPONENTS	●●●	●	●			●●●	●●●	●●	●	●●	●	●●●
ELECTRONICS	●●●	●●	●●●	●●●		●●●	●	●●		●●●	●●	●●●
HYDRAULICS, LIQUIDS PROCESSING, HEAT EXCHANGE		●●			●●●					●●●		
TELEVISION Studio, Theatre, Educational, Business, Industrial	●	●		●●●		●				●		
INSTRUMENTS, SERVOS, CONTROLS Hydraulic, Pneumatic, Magnetic, Electronic	●●●	●	●●	□●●		●●●	●●	●●		●●●	●	●●●
AIRCRAFT and MISSILE GUIDANCE, CONTROL, SIMULATION	●●●	●		●●●		●●●	●			●●	●	●●●
AUTOMATIC COMPUTERS and COMPONENTS	●●●	●	●	□●●		●●●				●●●		●●●
RADAR, MICROWAVE, ULTRASONICS	●●●	●	●●	●●●		●●		●		●		
MOTION PICTURE and AUDIO EQUIPMENT		●●●		□●●			●●	●●●	●●●		●●●	
NUCLEAR POWER COMPONENTS and CONTROLS	●●●				●●					●●		●●●
SYSTEMS ENGINEERING Aeronautical, Naval, Industrial	●●●			●●●	●●●	●●●				●●●		●●●

THE GPE PRODUCING COMPANIES

A brochure relative to GPE Coordinated Precision Technology and the work of the GPE Companies is available. Address your request, or inquiries on specific problems, to:

General Precision Equipment Corporation

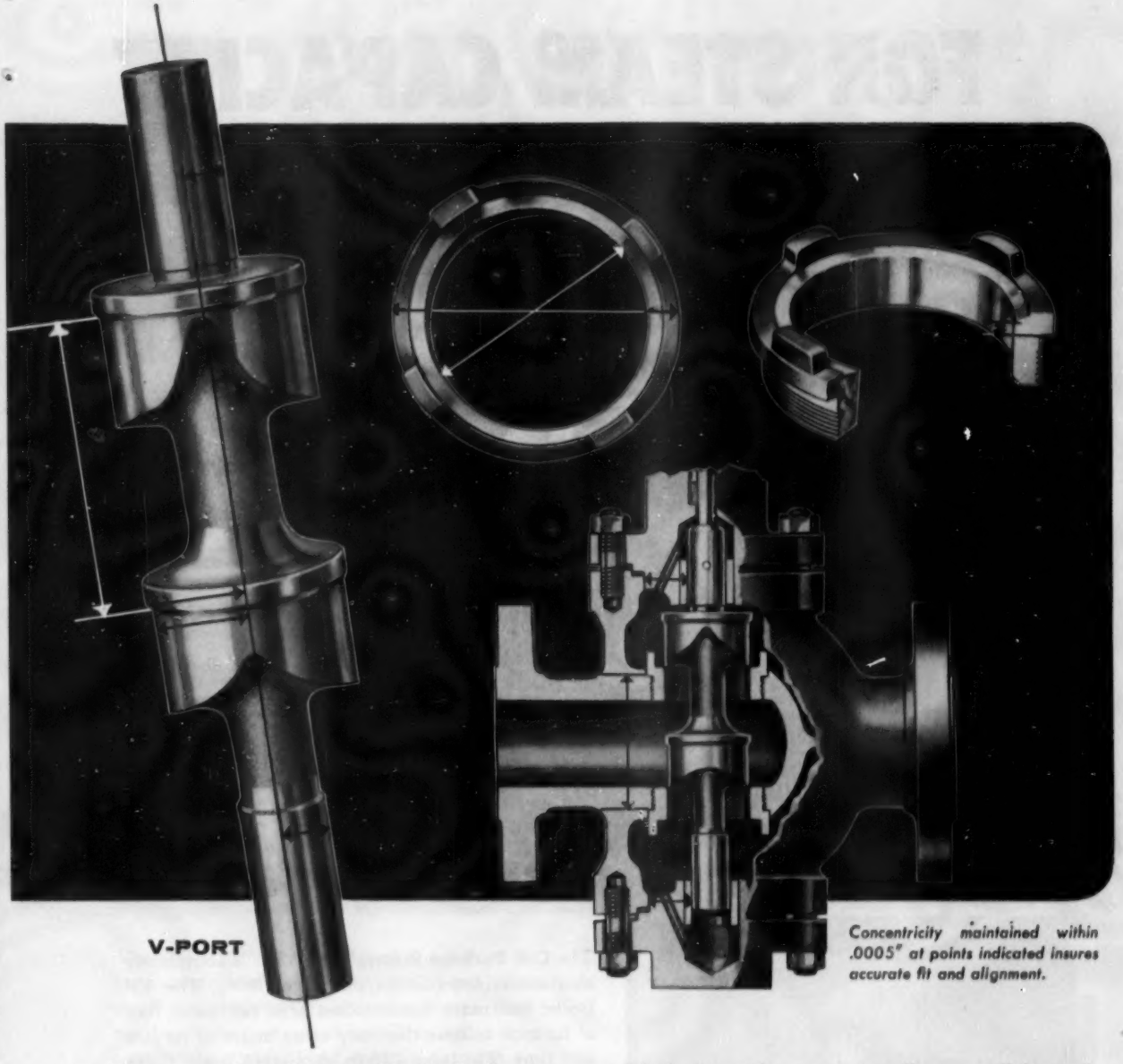
92 GOLD STREET, NEW YORK 38, NEW YORK

INTERCHANGEABLE PARTS

An Important Factor in Uniform Quality of Masoneilan Control Valves

You have a right to expect to be able to install replacement parts without recourse to a machine shop for custom fitting. When you use Masoneilan Control Valves you *get* parts that fit. For Mason-Neilan precision methods, automatic machines and specially designed tools and gages, plus rigorous inspection, eliminate the maintenance man's headaches and reduce costly time out of service.

By maintaining this precise uniformity, Mason-Neilan makes certain that every valve will be in perfect alignment and that any



V-PORT

Concentricity maintained within .0005" at points indicated insures accurate fit and alignment.

parts you may install later will also be in perfect alignment.

Moreover, because valve plugs of comparable size but different flow characteristics are interchangeable, conversion is a comparatively simple operation.

These quality features, added to other outstanding qualities of Masoneilan Control Valves, offer you low *cost* at comparable *price* — and over-all cost not price is the valid comparison.

Investigate the practical advantages of Masoneilan Control Valves. Write for complete data.

MASONEILAN

MASON-NEILAN REGULATOR CO.

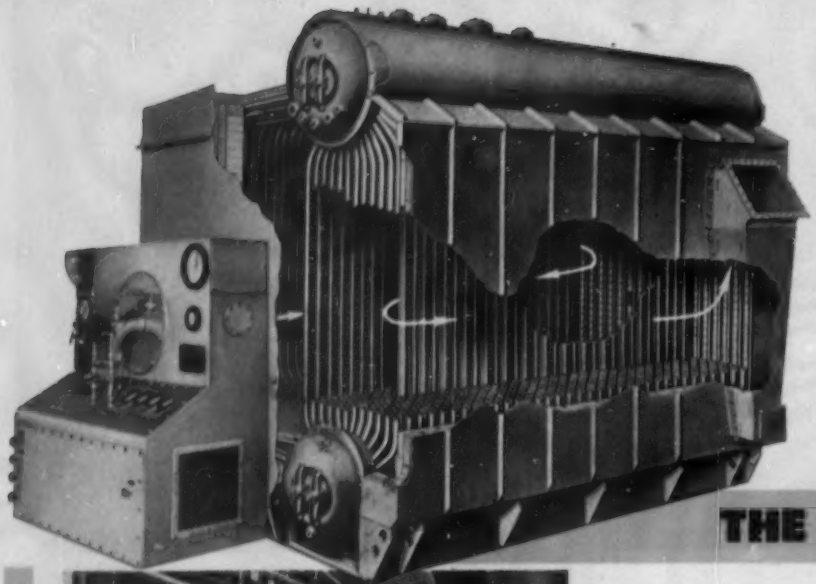
1186 ADAMS STREET, BOSTON 24, MASS., U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco Boise • Louisville • Salt Lake City • El Paso • Albuquerque • Odessa • Charlotte • Los Angeles Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Dallas • Seattle Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

FOR STEAM CAPACITY
choose your boiler

Whatever your fuel . . . whatever your steam capacity requirements up to 60,000 pounds per hour — you'll find one of the C-E Boilers shown here will be just right for you.

If you burn oil or gas, investigate the VP Pack-



Specifications — VP Boiler

Capacity — 4,000 to 40,000 pounds of steam per hour

Pressures — Up to 500 pounds per square inch

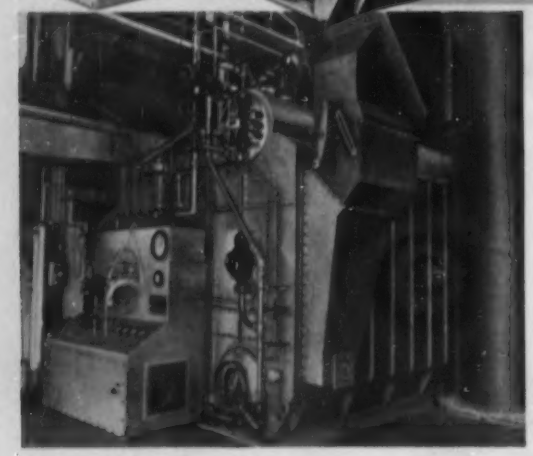
Temperature — No superheat

Fuel — Oil or gas

Erection — Completely shop-assembled

Foundation — Simple concrete slab

THE VP BOILER



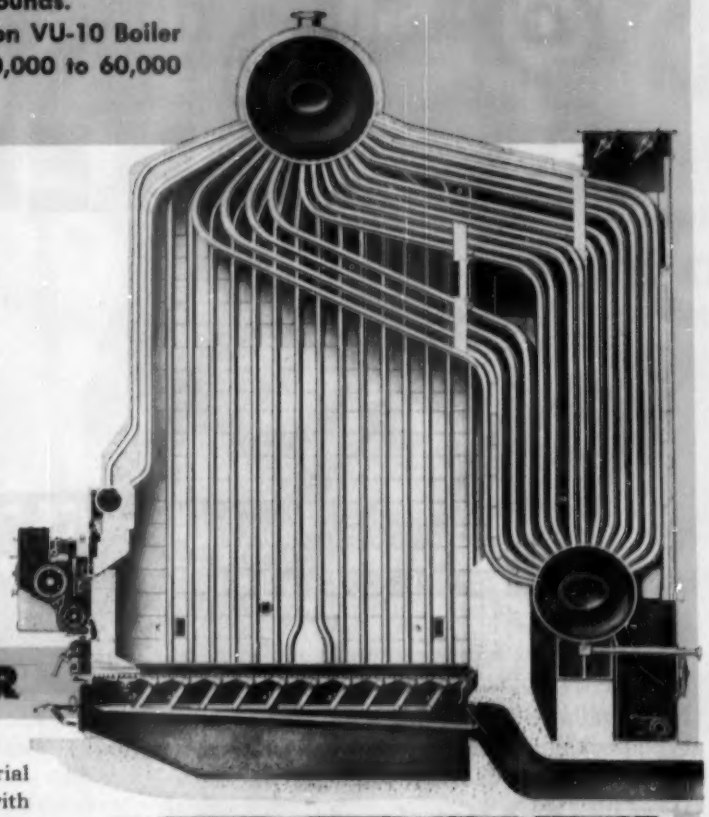
The C-E Package Boiler, Type VP . . . completely shop-assembled . . . for oil or gas firing. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large (30-in. diameter) lower drum permits a simple, symmetrical, tube arrangement... greater water storage capacity . . . easy access for washing down or inspection. A low-speed, centrifugal fan which is exceptionally quiet in operation, is standard equipment. Baffle arrangement is simple, resulting in low draft loss . . . simple soot blowing . . . high heat absorption. The unit is pressurized . . . has welded, gas-tight, steel casing . . . requires no induced-draft fan. Write for Catalog VP.

COMBUSTION ENGINEERING

UP TO 60,000 POUNDS
from these two

age Boiler for capacities up to 40,000 pounds per hour . . . the VU-10 up to 60,000 pounds.

For stoker firing, the Combustion VU-10 Boiler is available in capacities from 10,000 to 60,000 pounds of steam per hour.



Specifications — VU-10 Boiler

Capacity — 10,000 to 60,000 pounds of steam per hour

Pressures — Up to 475 psi

Temperatures — Superheat available if desired

Heat Recovery — Economizers, air heaters available if desired

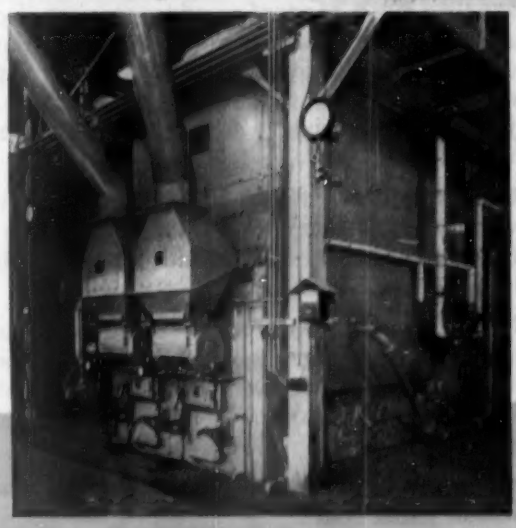
Fuel — Coal (C-E Spreader, Traveling Grate or Underfeed Stoker); oil or gas.

Erection — Field erected

THE VU-10 BOILER

The VU-10 Boiler is designed for industrial load conditions, particularly for plants with small operating and maintenance forces. Fuel can be either coal, oil or gas. This boiler is a completely standardized design adaptable to many conditions. It responds readily to variations in load; it is simple to operate and maintain. All parts are easily accessible for inspection. Like the VP, the VU-10 Boiler is a complete unit — boiler, furnace setting, fuel-burning equipment, controls, forced draft — bringing you the benefit of one contract . . . one guarantee . . . one responsibility. Write for Catalog VU-10.

B-858



C-E

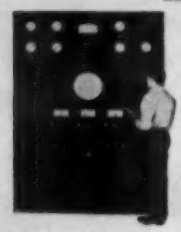
BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

CANADA: COMBUSTION ENGINEERING—SUPERHEATER, LTD., MONTREAL

for the man considering a PACKAGE BOILER

new all-electric METERING TYPE PACKAGED CONTROL by HAYS



Now available for *all* makes and sizes of water tube type package boilers is the new all-electric, metering type Hays packaged control.

Metering type control provides maximum combustion efficiency regardless of the fuel burned because it *actually meters* the fuel flow and air flow, and automatically maintains the desired ratio. No adjustments are needed when changing fuels or oil burner tips.

All-electric operation includes not only safety devices but also steam, fuel, and air controllers and valves—uses only the normal source of AC voltage. No compressed air is required.

Fully automatic, safe and reliable operation is assured because Hays maintains the same industrial quality built into the largest utility combustion control system and it is factory tested before shipment.

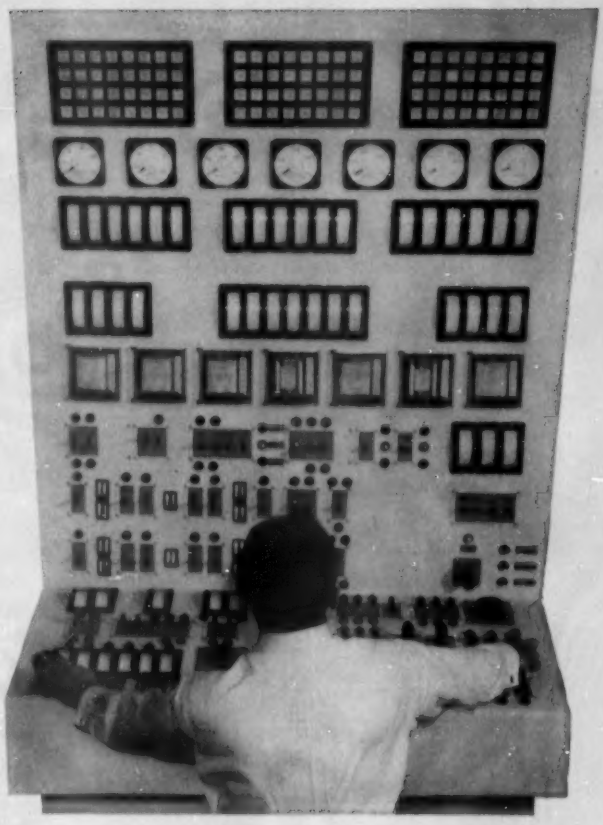
Complete package in one simple and inexpensive to install panel board.

Write today for fact-filled Bulletin 53-1088-239.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY, 3, INDIANA



NEW DIMENSIONS in boiler plant instrumentation

Controlling a giant boiler, turbine, and generator from a panel 4 feet wide!

At Ninemile Point Plant of the Louisiana Power and Light Company, the new third unit is controlled by the unusually compact B.T.G. control panel shown here. The B.T.G. (Boiler-Turbine-Generator) panel built by Hays is an innovation of Ebasco Services, Incorporated.

Practically every detail of the third unit of Louisiana Power's new Ninemile Point generating plant is of the newest design. An all-weather outdoor boiler with Hays electric type combustion control—gas fired, with provisions for "stand-by" oil firing—will produce over 1,000,000 lbs. of steam per hour, superheated and reheated to 1,005°F.

On outdoor boilers electrically operated combustion control is especially preferred because it doesn't require expensive compressors and dryers, allows maximum freedom in control room location. For greater speed of response and accuracy new Hays electronic instruments, including electronic mercury-less flowmeters and 3 element electronic feed water control are being installed.

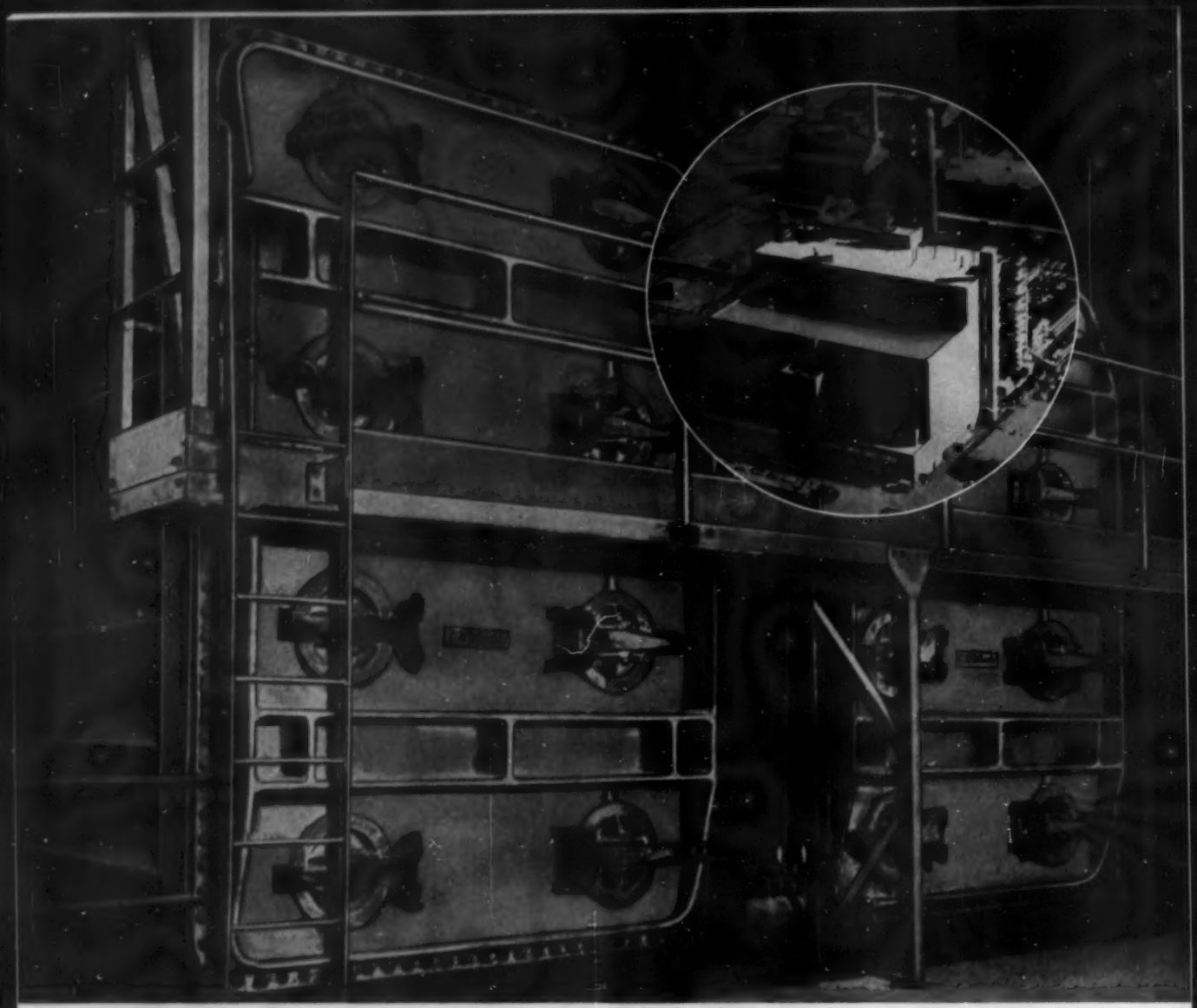
Among the central stations recently selecting Hays instrumentation and control are: Jersey Central Power and Light Co., Northern Indiana Public Service Co., Central Illinois Electric and Gas Co., St. Joseph Power and Light Co., Crawfordsville Power and Light Co.

Write for Hays Boiler Plant Instrumentation Bulletin 54-605-83.

THE **hays** CORPORATION

MICHIGAN CITY, 3, INDIANA

Automatic Combustion Control · Vaillow Meters and Varitrol · Electronic Oxygen Recorders · CO Recorders Boiler Panels · Gas Analyzers · Combustion Test Sets Draft Gages · Electronic Flowmeters · Miniature Remote Indicators · Electronic Feed Water Controls



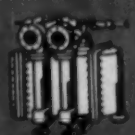
STEAM CONDENSERS at
CONSOLIDATED EDISON'S ASTORIA STATION
feature C. H. WHEELER ADVANCED DESIGN

C.H. Wheeler

Steam Condensers and Auxiliaries

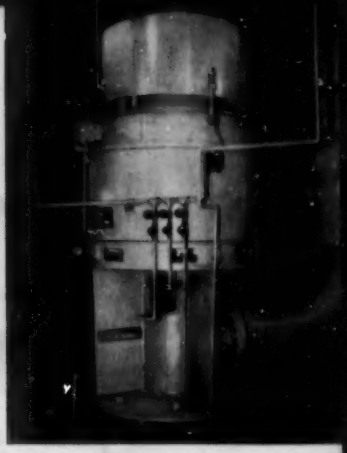
Centrifugal, Axial and Mixed Flow Pumps

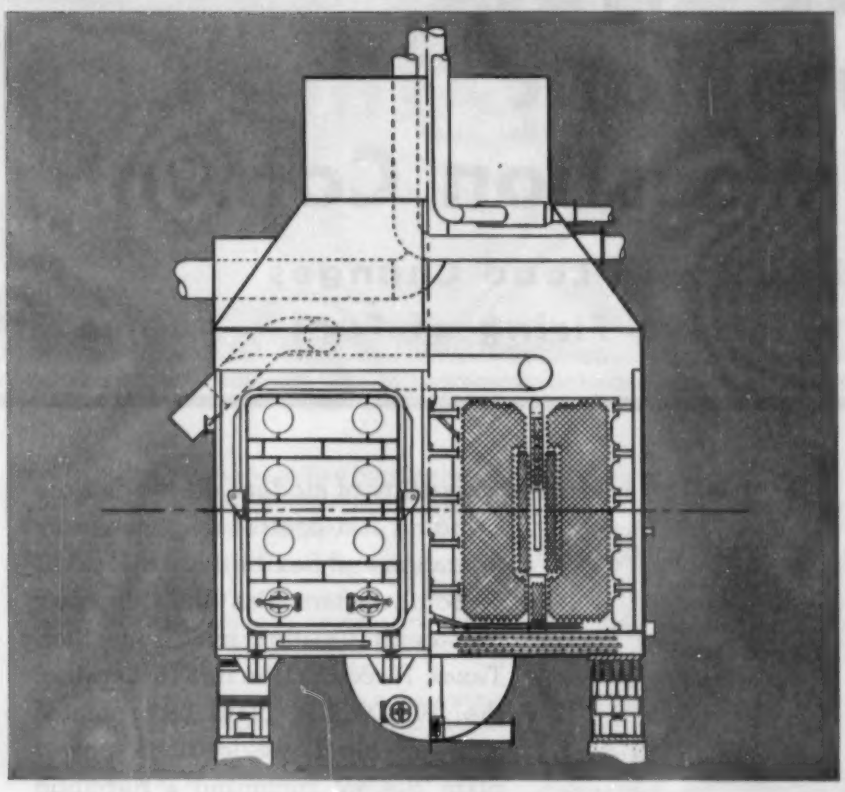
Steam Jet Ejectors High Vacuum Process Equipment


Marine Condensers and Ejectors

Steering Gear

Deck Machinery Marine Pumps





TOP LEFT — These four condenser circulating water pumps, installed at the Astoria Station of Con Edison Company in New York, are of the removable type with under floor discharge. Each pump has a capacity of 68,500 GPM; 16' TDH; 233 RPM.

CENTER — Operating at Con Edison's Astoria Station in New York, each 2 stage element of this twin element, 2 stage air ejector, is designed to remove 37.3 lbs. per hour of air saturated with water vapor, from condenser at 1" mercury absolute. Inter and after condensers are in separate shells.

TOP RIGHT — One of four 18"x20" vertical salt water service pumps in operation at Con Edison's Astoria Station. Capacity is 8,000 GPM; 100' TDH; 550 RPM.

LEFT — Arrangement of Tube Bundles in C. H. Wheeler Dual Bank Steam Condensers installed at Consolidated Edison's Astoria Station. Each unit is designed to condense 950,000 lbs. of steam per hour.

Two dual bank steam condensers of divided water box design, like the one shown above, are installed by C. H. Wheeler at Consolidated Edison Company's Astoria, N.Y. Station. Each unit contains 15,450 tubes with 105,000 sq. ft. of condensing surface. One of the principal features of these C. H. Wheeler Steam Condensers is the advanced design of layout for the tube banks. Path of steam travel is shorter and distribution to the tubes is greater, resulting in smaller pressure drop.

C. H. Wheeler specially engineered each condenser unit to facilitate the quick start requirements of the Consolidated Edison system. Steam can be dumped directly from the boiler during periods when the boilers are being brought up to temperature corresponding to the turbine parts.

C. H. Wheeler has been singularly successful with advanced designing in these extremely large units, achieving minimum pressure drop in the tube bank, along with generous steam distributing space. The C. H. Wheeler design is also well suited for deaerating where there are rigid specifications on oxygen content in the hotwell discharge.

There is a reason for C. H. Wheeler's leadership in the field of steam power generation. We urge you to investigate C. H. Wheeler to insure your success with your next important project.

WE-801

C. H. WHEELER MANUFACTURING COMPANY

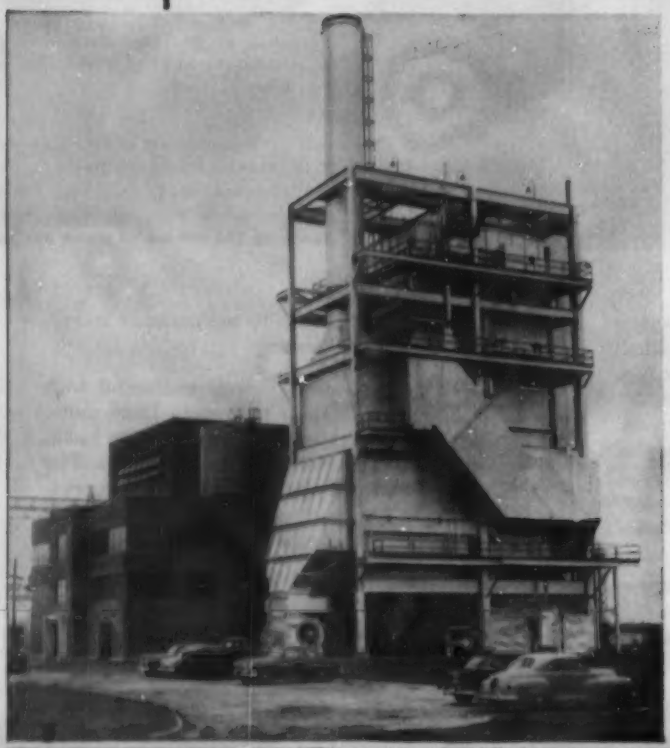
19th & Lehigh, Philadelphia 32, Pa.

AT NEW LONE STAR STATION

REPUBLIC Automatic Combustion Control

Handles Rapid Load Changes and Selective Firing of Fuels

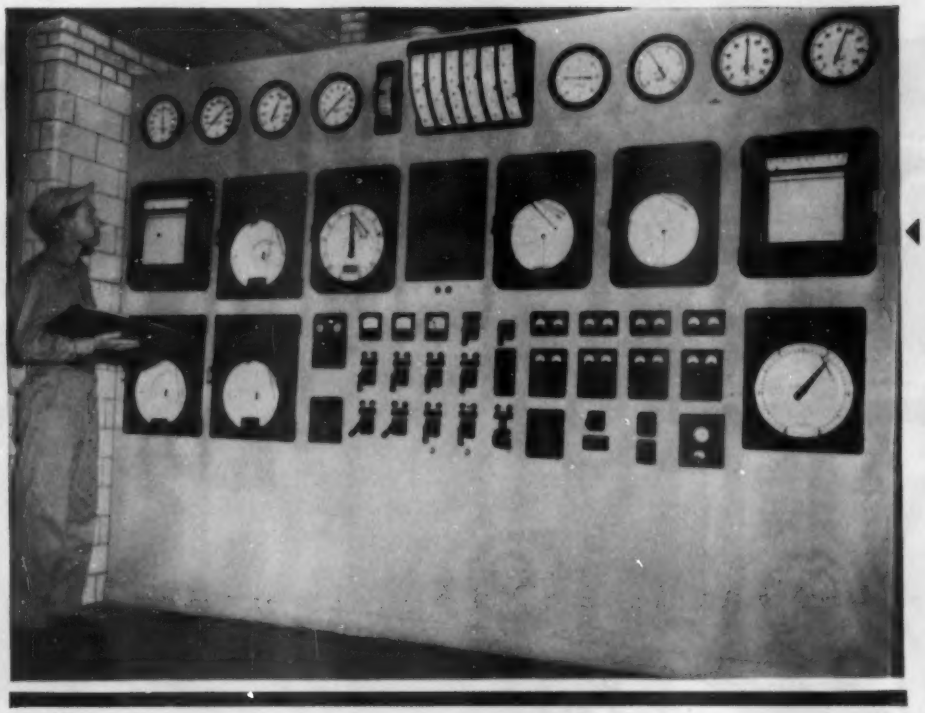
● The speed and versatility of modern electronics are bringing fast control response, easy operation and flexibility in fuel firing to Southwestern Gas and Electric's new central station near Lone Star, Texas. Placed on the line this spring, the 54,000 KW plant incorporates many of the latest ideas in power plant design, including a Republic Automatic Combustion Control System with Telemaster Electronic master control.



Lone Star Station, Lone Star, Texas
Southwestern Gas and Electric Company
Sargent and Lundy, Engineers

Steam generator is the outdoor type with a pressurized furnace. It is designed for maximum steam output of 470,000 lbs. per hour at 920 psig and 910° F. at the superheater outlet.

REPUBLIC FLOW METERS CO.



Electronic master controls at this panel provide for either steam pressure or steam pressure-load control, manual setting of fuel-air ratio, fuel valves, draft fans, and selection of one of four firing methods.

The plant is arranged to fire both natural and coke oven gas. Automatic fuel selector controls provide for four firing combinations:

#1 Automatic preferential control of coke oven gas in accordance with its availability, with sequential make-up of natural gas.

#2 Manual control of the coke oven gas proportion, with sequential make-up of natural gas.

#3 Block or adjusted constant flow of natural gas with coke oven gas make-up.

#4 Block, or adjusted constant flow of coke oven gas, with natural gas make-up.

Extremely fast load changes are common at the Lone Star plant. Immediate control response is possible, however, because the system uses a new type load control to get the earliest indication of a load change and provide the initial impulse for controlling fuel and air to the boiler. Electronic impulses to positioners and regulators eliminate transmission lags—enable control equipment to make immediate compensations for changing loads. Steam pressure control is also possible if desired.

According to Mr. John Turk, Chief Engineer, the electronic control system is extremely simple to operate. Operators regularly run the plant on automatic between maximum capability and a minimum load of 15,000 KW, although wide range automatic operation was not planned when the control system was designed. The three-element Republic feedwater control in the plant is left on automatic to essentially zero load.

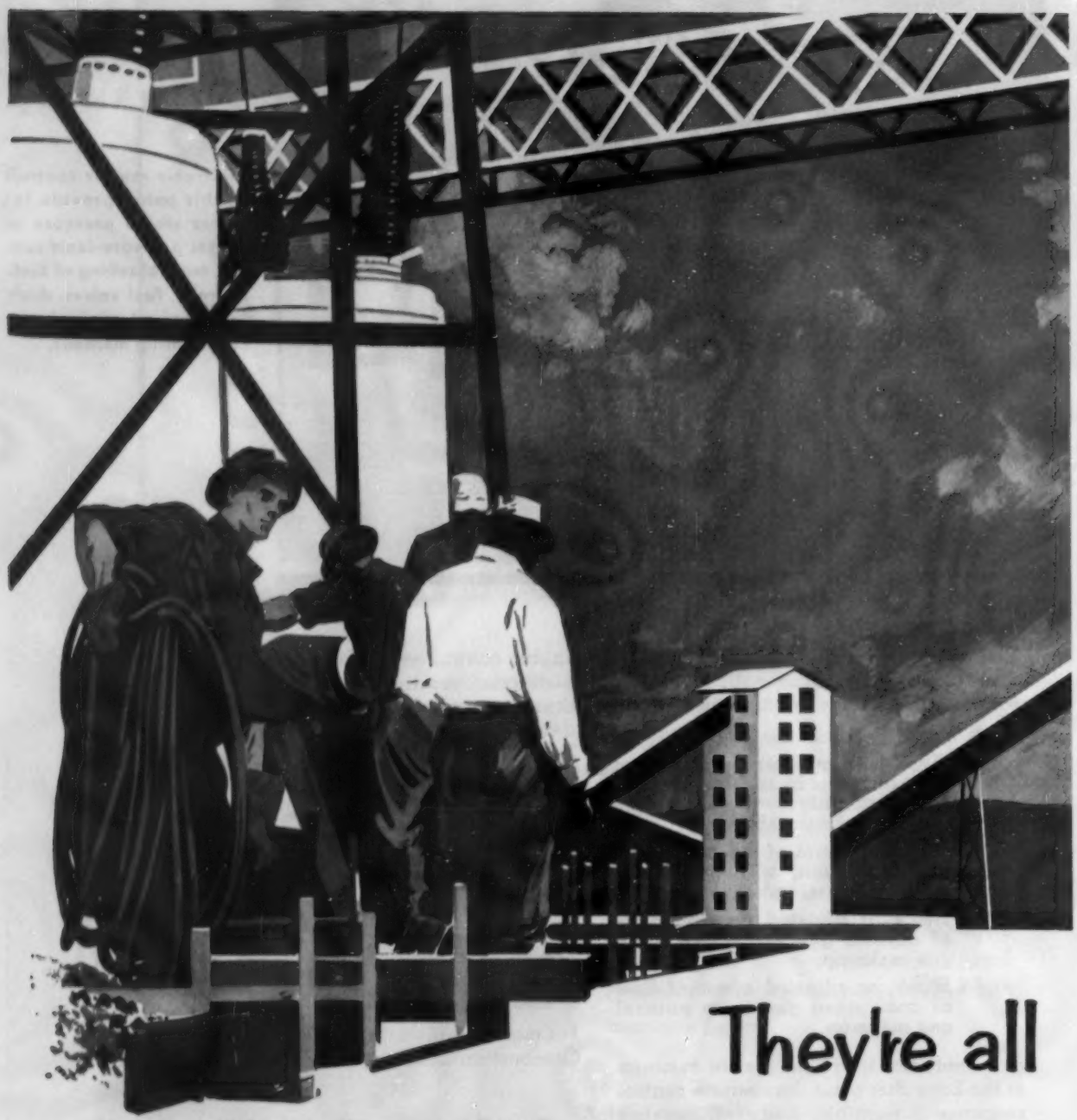
For more complete details about Republic Combustion Controls, write for Data Book.

●

Republic brings you the latest features in Automatic Combustion Controls

- ★ For all types and sizes of boilers
- ★ For all arrangements of draft
- ★ For all types of fuel firing
- ★ For all load conditions

2240 Diversey Parkway • Chicago 47, Illinois



They're all

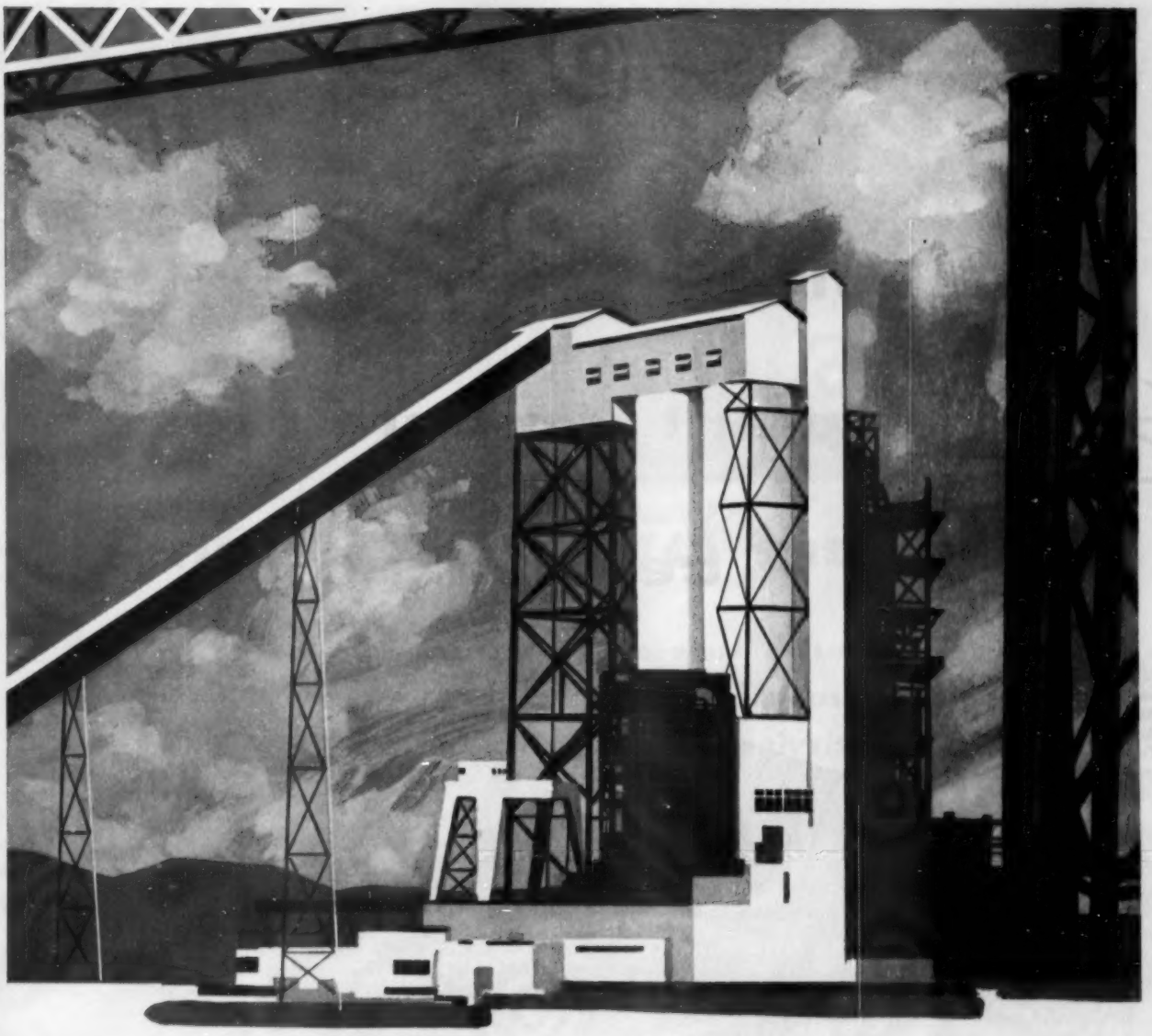
The Pennsylvania Power & Light Company can well be proud of its new steam generating station at Martins Creek. For this station has the distinction of being one of the first "outdoor-design" generating facilities in the northern United States.

Consisting of two 132,500 kw generating units—one now in operation, its twin to be completed in 1956—Martins Creek will require 60 tons of coal per hour to feed each unit! To cope with this gargantuan appetite, the Pennsylvania Power & Light Company and their consulting engineers, Ebasco Services, turned to Hewitt-Robins to design, furnish and install a completely automatic coal handling system.

As a result, a 600 ton per hour capacity system now unloads coal for the first unit directly into a hopper with a Hewitt-Robins Heavy-

HEWITT-ROBINS INCORPORATED

CONVEYOR BELTING · INDUSTRIAL HOSE · CONVEYOR MACHINERY · VIBRATING SCREENS · VIBRATING CONVEYORS



steamed up at Martins Creek

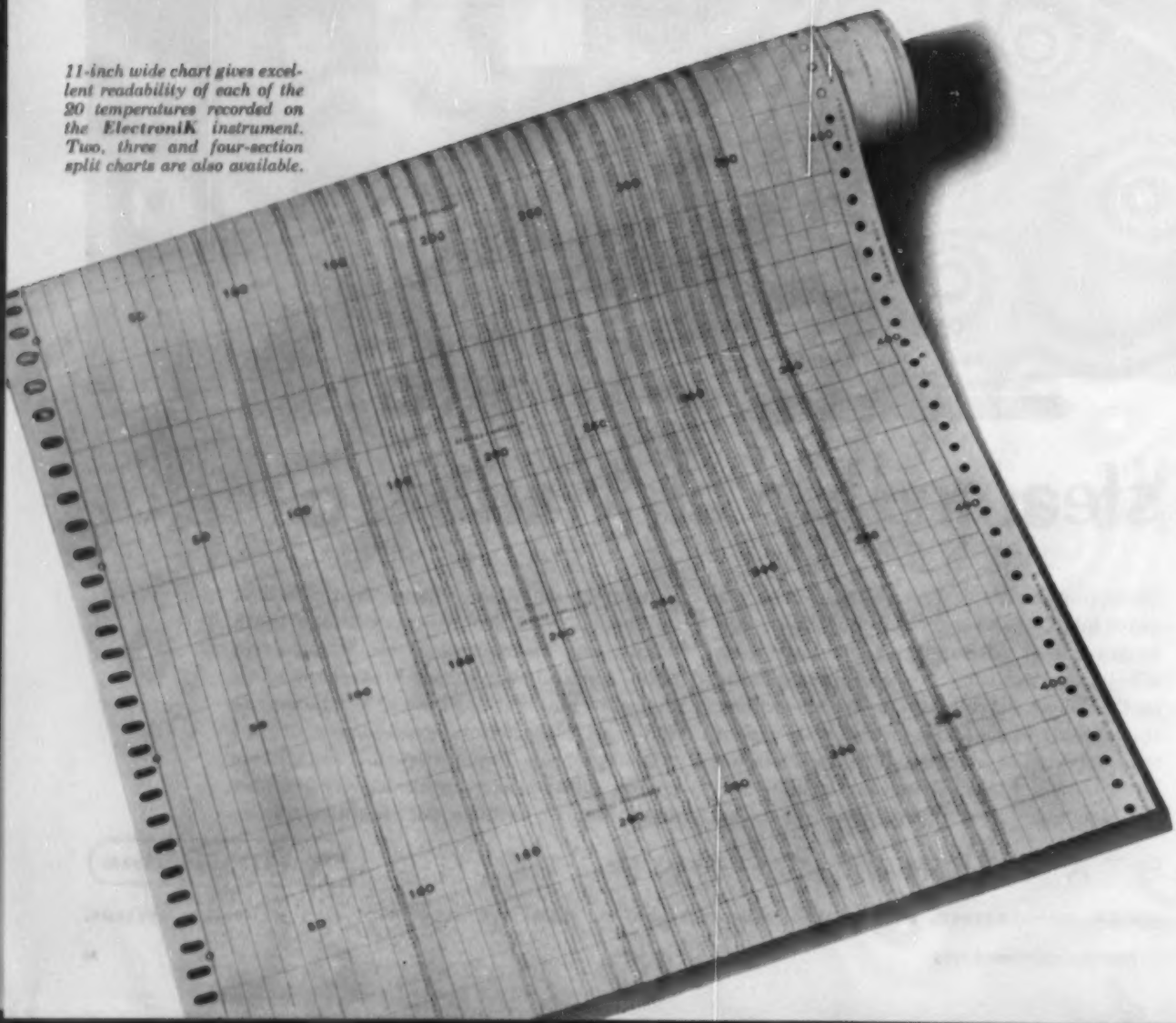
Duty Car Shakeout. From here, a belt conveyor takes it to a Gyrex® scalping screen that feeds a crusher. After crushing, another system of belt conveyors carries the coal either directly to the boiler silo bunkers or to an outdoor storage area where it is stockpiled through a telescoping chute controlled by a RoBINtronic Level Indicator. The entire coal handling system is designed so a duplicate may be added and integrated when required in the future.

Whether it's a belt conveyor system (both belting *and* machinery) to convey solids in bulk—vibrating equipment to screen, feed or shake out material—or hose to handle liquids and gases, Hewitt-Robins can solve your particular problem, large or small. Contact our nearest sales office, your local Hewitt-Robins distributor, or write to our executive offices.

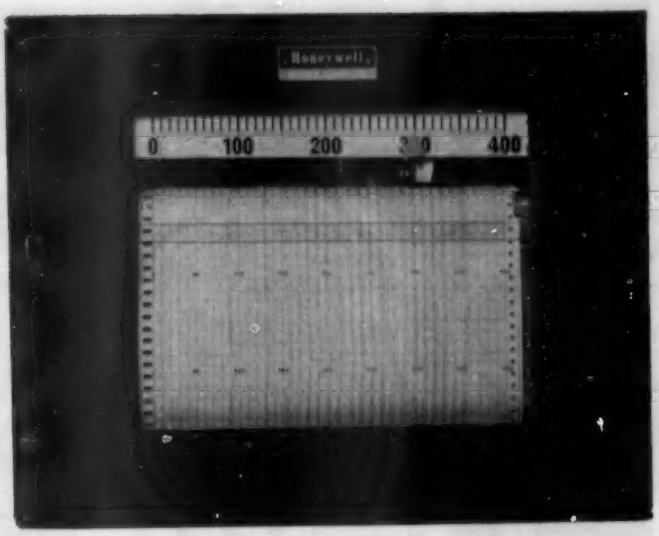
STAMFORD, CONNECTICUT **Hewitt-Robins**

DESIGN, MANUFACTURE, ENGINEERING AND ERECTION OF COMPLETE BULK MATERIALS HANDLING SYSTEMS.

Detailed records of 20 plant temperatures centralized on a



11-inch wide chart gives excellent readability of each of the 20 temperatures recorded on the ElectroniK instrument. Two, three and four-section split charts are also available.



single *ElectroniK* instrument

One instrument does the work of several . . . saves panel space . . . brings related measurements together for easier, clearer analysis of trends

UP TO 20 different temperatures . . . of water, steam, oil, air, hydrogen, bearings, generator stator or other critical spots . . . can be recorded by this *ElectroniK* instrument. This large capacity reduces your instrumentation investment . . . for one instrument can do the work that used to require two conventional recorders. At the same time, panel space for temperature measurements is cut in half.

When you're choosing temperature instrumentation, specify the 20-point *ElectroniK* recorder, to be sure of obtaining—

The kind of records you want. All 20 records can be printed on a chart with a single range, as illustrated here. To separate curves and avoid overlapping, charts with two, three or four separate split sections can be provided.

The recording speed you need. The instrument can be supplied to record at a rate of 30, 15, 5 or 2 seconds per point. You can choose the frequency of temperature checking that your plant requires.

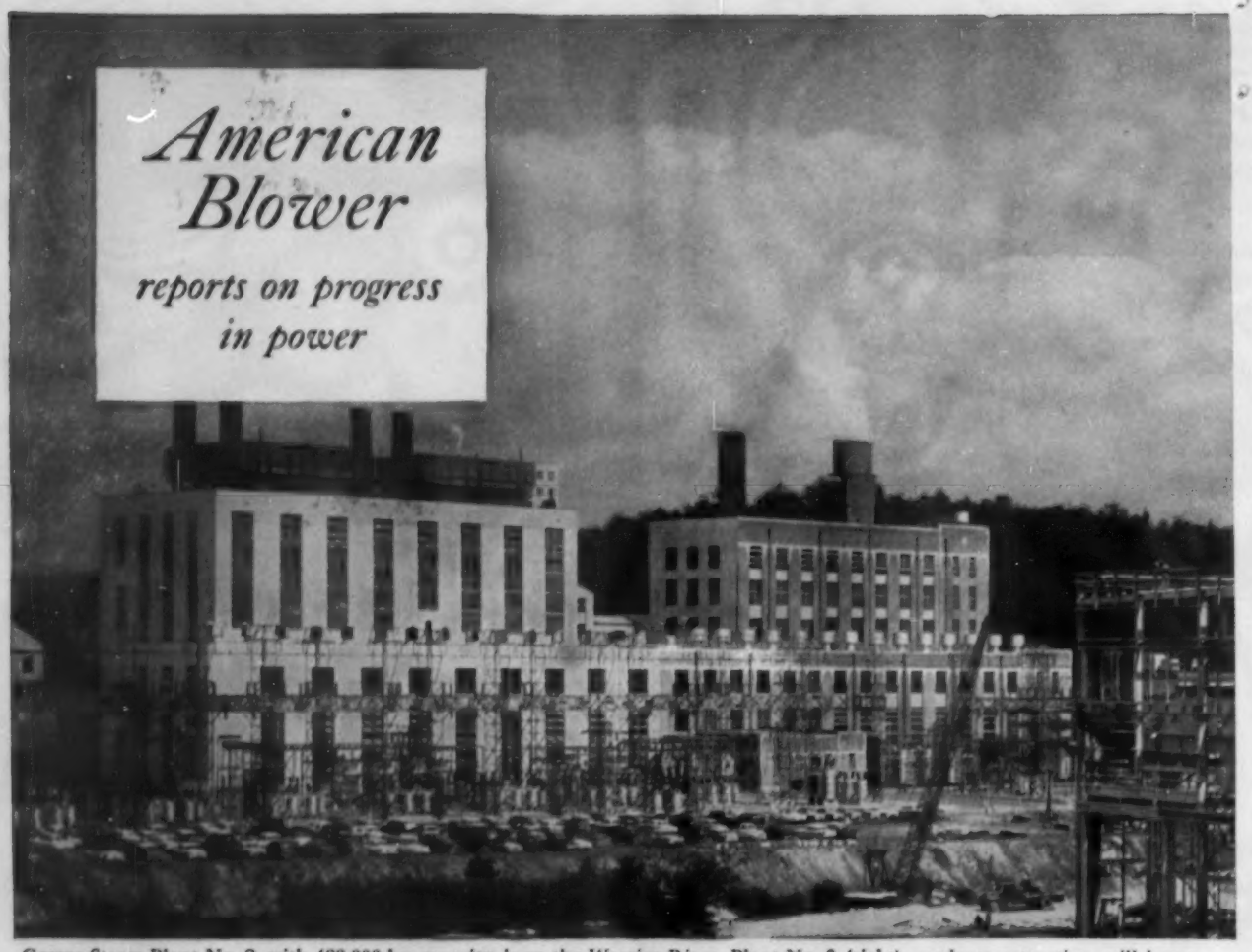
The dependability you demand. Thousands of *ElectroniK* instruments, in power plants and other industrial service, have earned a world-wide reputation for reliability. Their rugged, simple designs make use of basic components engineered for the utmost in long life and precision. In installation, start-ups and emergencies, service is available promptly from Honeywell's coast-to-coast organization.

Ask your local Honeywell sales engineer to come in for a discussion of your power plant measurement problems. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Specification Sheet No. 165-1, "*ElectroniK* Strip Chart Recorders." Bulletin No. 9050R, "Instruments for Steam Generation."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



Gorgas Steam Plant No. 2, with 428,000 hp capacity, is on the Warrior River. Plant No. 3 (right), under construction, will house

Alabama Power ups capacity to

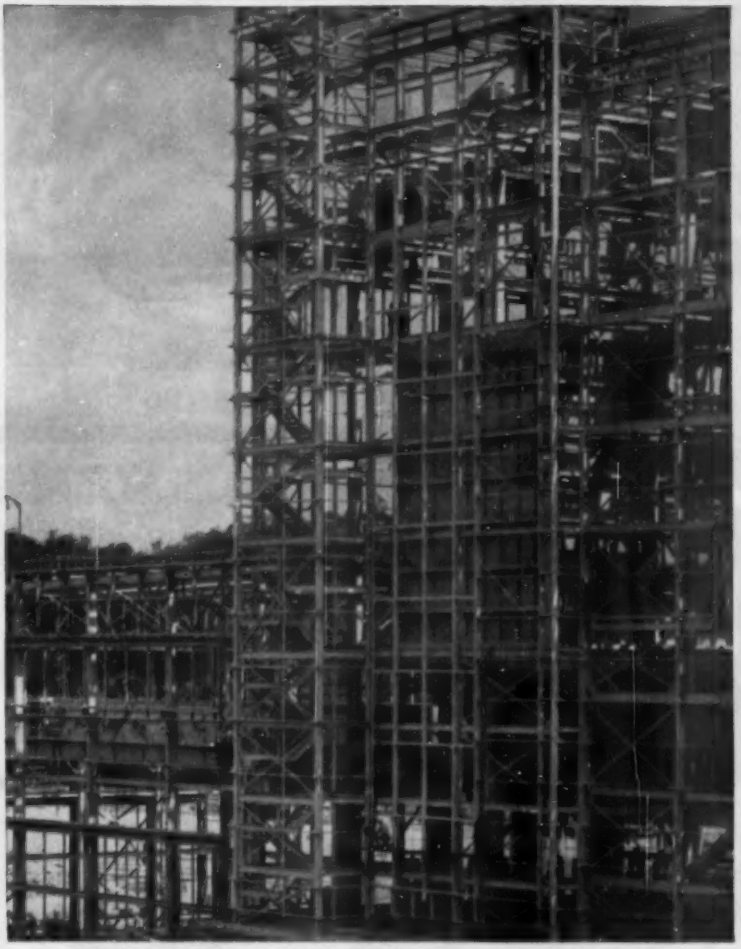
While Gorgas Steam Plant No. 3 is being built, American Blower constructs two Fly Ash Precipitators which will be installed in this new plant. Ratings: 340,000 cfm @ 285° F.

As in the past, Alabama Power installs American Blower equipment—in building for the future

With six steam and six hydroelectric plants, the Alabama Power Company forges ahead for the future of Alabama. In 1955 alone, it will invest more than $35,000,000 in bigger and better electrical facilities, including an eighth generating unit at their Gorgas Steam Plants. When completed this year, Alabama Power's capacity will be over 2,000,000 hp!

American Blower Forced and Induced Draft Fans, Fly Ash Precipitators and Gyrol Fluid Drives are being installed in this new plant.

From coast to coast you'll find American Blower playing an important role in the expansion and modernization of many other progressive, investor-



No. 8 generating unit, rated at 208,000 hp.

Gorgas Unit No. 7 uses American Blower Fans with Gyrol Fluid Drives. Induced Draft Fans (above) are rated @ 262,500 cfm @ 270° F @ 15.25" sp @ 569 rpm.

American Blower Forced Draft Fans on Unit No. 7 at Alabama Power's Gorgas Steam Plant are capable of 180,000 cfm @ 140° F @ 11.00" sp @ 868 rpm.

over 2,000,000 hp!

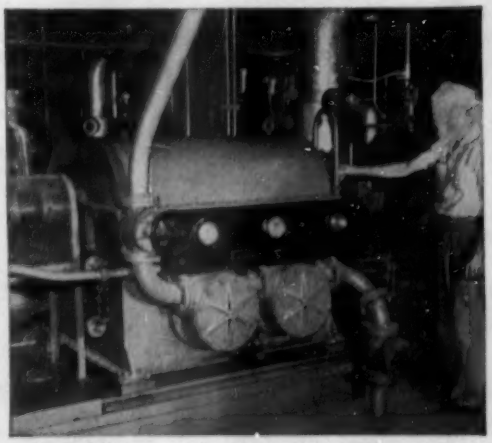
owned utilities. Plant operators have come to rely on American Blower Heavy-Duty Steam Coils and Fly Ash Precipitators, as well as our Mechanical Draft Fans, Dust Collectors, and Gyrol Fluid Drives for boiler-feed pump and fan control.

Give us a call to discuss *your* program. An experienced representative will gladly go over your requirements, and recommend equipment of the highest efficiency and economy. Contact your American Blower or Canadian Sirocco Branch Office.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER



In addition to fan control, American Blower Gyrol Fluid Drives — class VI, 1500 hp — are used for adjustable speed control of boiler-feed pumps.

now . . . from

ONE SOURCE with UNDIVIDED RESPONSIBILITY

a complete line of controls and valves for commercial and industrial burners . . . automatically, semiautomatically, or manually ignited

SAFEGUARDS and PRIMARY CONTROLS

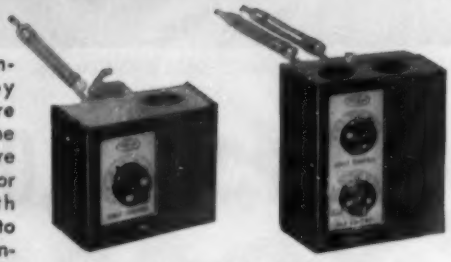
The FP-2 and FJ-2 systems provide complete flame-failure protection and programming for automatically ignited burners. Shut off fuel in 2 to 4 seconds after flame failure. Limit trial for ignition. Purge combustion chamber before and after firing.

System FP-2 for industrial burners

fireye®

OPERATING CONTROLS

Fireye automatic controls, operated by changes in temperature or pressure, are of the highest quality. They are available individually or in combination with other Fireye controls to make a complete control system.

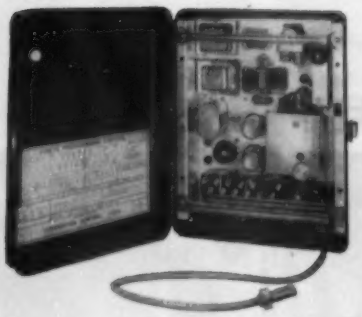


Air Temperature Controls

Immersion Controls

Thermostat

Pressure Controls



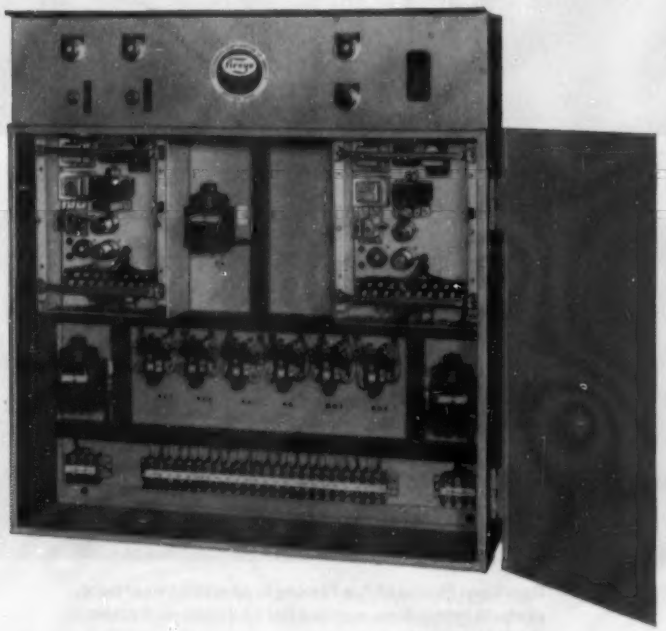
System FJ-2 for commercial burners

System FP-3 for flame-failure indication and alarm

System FP-4 for semiautomatically and manually ignited burners

NEW SAFETY INTERLOCK SYSTEM

The first fully integrated combustion safeguard system for multiple burner boilers . . . insures safe light-off and firing. Includes all external valves, switches and alarms in addition to pre-wired cabinet assembly.



SMOKE INDICATORS

Provides low-cost, easy-to-install smoke indication with assured accurate readings. Meets *all* smoke ordinances.

System FE-3

VALVES

Manual Reset Valves

Leakproof closing action of these safety shutoff valves makes them ideal for automatically shutting off fuel flow to a burner in event of flame failure, fan or pump failure, power failure, etc.

Solenoid Fuel Valves

E C A

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In Canada, write Electronics Corporation of America, Canada (Ltd.) Box 111, 98 Advance Road, Toronto 18

Please send literature on the following Fireye Controls:

☐ Operating Controls ☐ Valves

☐ New Safety Interlock ☐ Smoke Indicators

☐ Primary Controls and Safeguards

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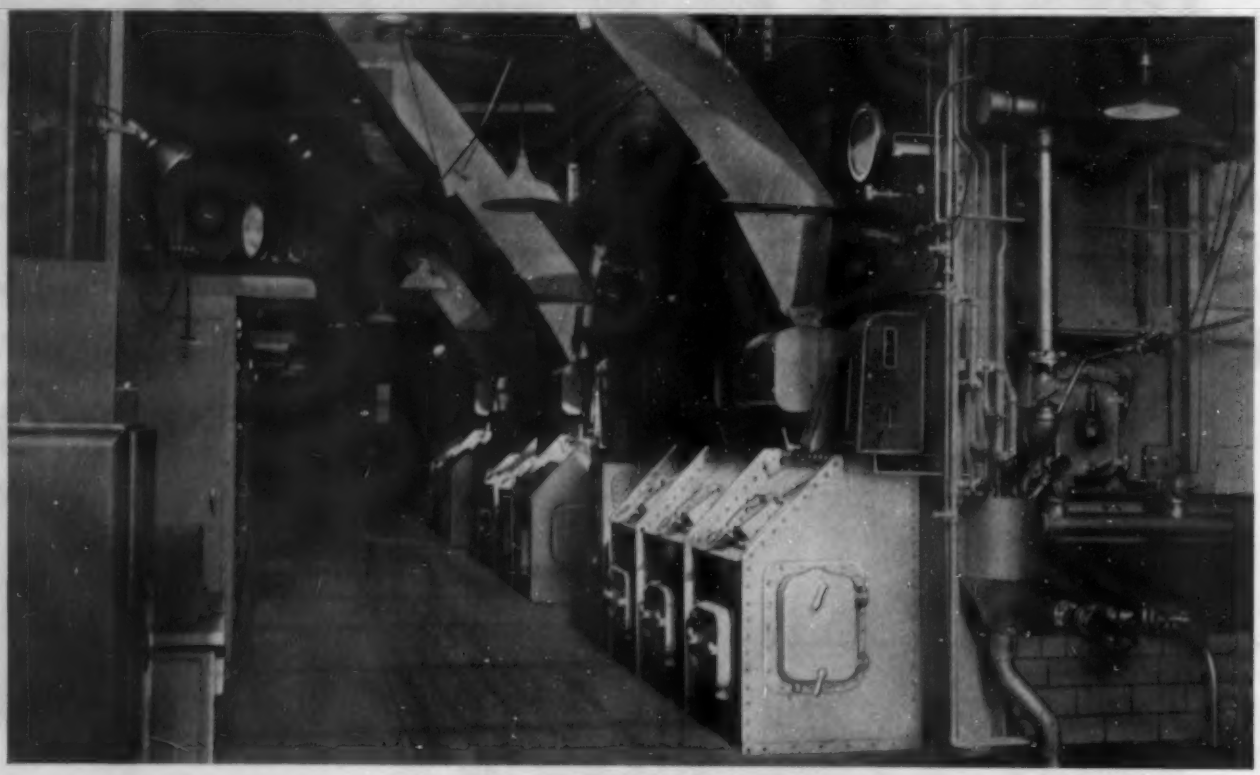
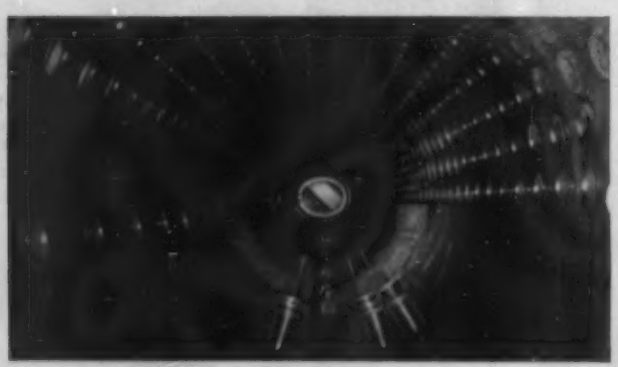
Dearborn gives a new

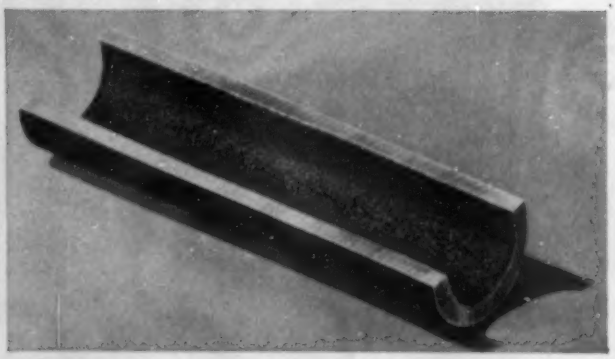


A typical power plant served by Dearborn.



Dearborn 639*, pumped continuously to deaerating heater, keeps this boiler clean.

* Pat. No. RE-23085



Dearborn Filmeen**, a filming type amine treatment, protects return lines against both oxygen and carbon dioxide corrosion.

** Pat. No. RE-23614

Dearborn®

A LEADER IN WATER CONDITIONING AND CORROSION CONTROL

ADDRESS

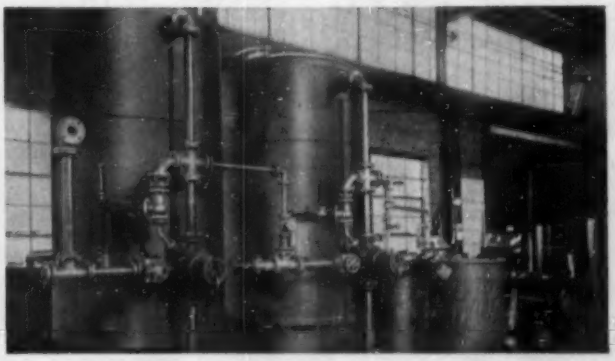
meaning to water treatment

The boiler room of this state institution is a model of efficiency in the generation of power. Here, the constant control of steam purity is the result of a complete water treatment program tailored to meet plant requirements in every respect. Dearborn Supervisory Service brings you the same advantages in the proper treatment of source water to get top results.

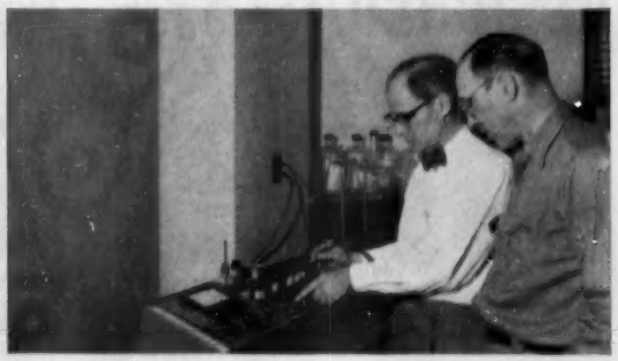
Positive control has been so successfully provided by Dearborn water treatment methods that today, industrial and commercial plants, institutions and utilities are turning to Dearborn for consultation and assistance in—

- ★ Internal or external feed water treatment
- ★ Steam purity control
- ★ Feeding, softening or de-ionizing equipment
- ★ Cooling water or process water treatment
- ★ Water reclamation
- ★ Industrial waste treatment

It may be that this specialized service is just what you need to correct conditions in your power plant. If you will set a time, your Dearborn Water Treatment Engineer will call and explain the many advantages of Dearborn Supervisory Service...a program in which you use only the amount of service you need.



Where mineral-free water is required, a Dearborn de-ionizing plant will reduce the mineral content to the equivalent of that produced by evaporation ... and at less cost.



Periodic tests establish continuous quality control so essential in maintaining high steam purity.

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☐ Please have a Dearborn Engineer call.
☐ Furnish me with more information on Dearborn Water Conditioning Service.

Name..... *Title*.....
Company.....
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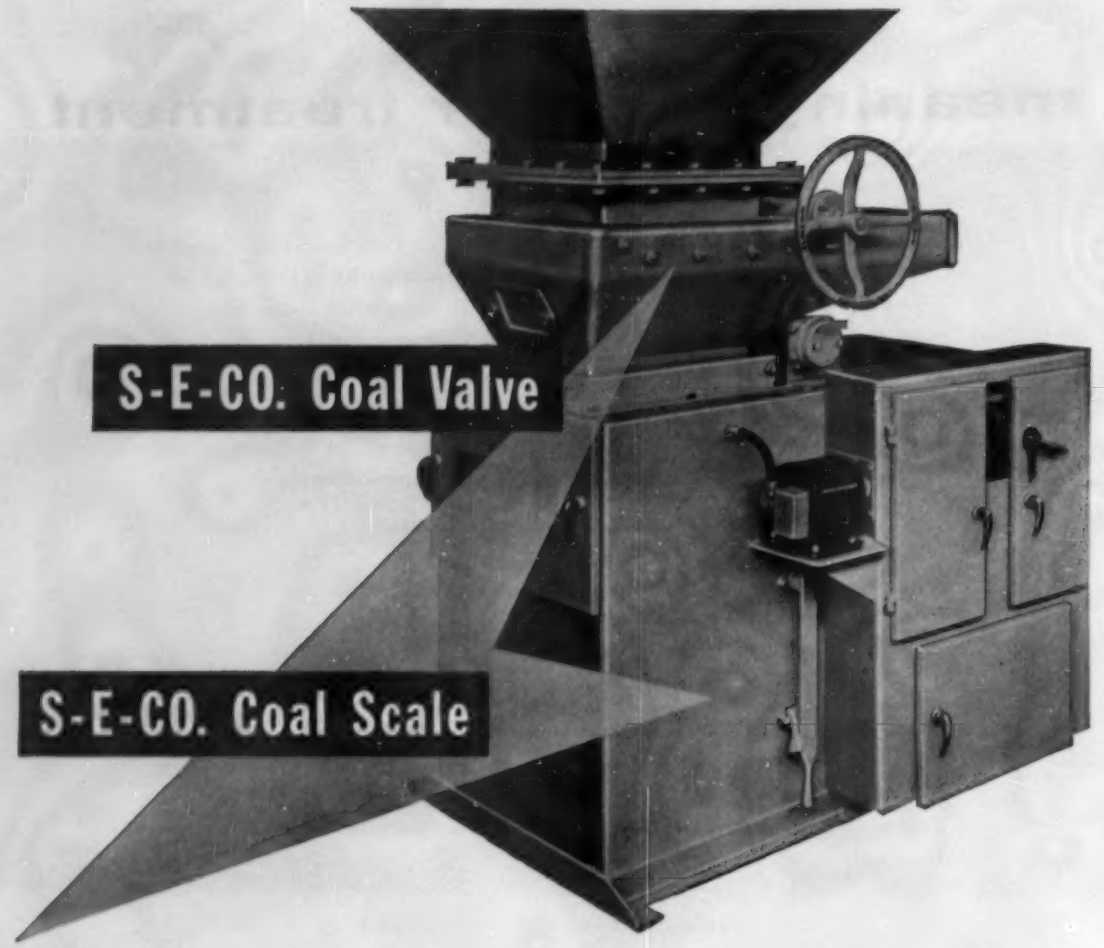
City..... *Zone*.... *State*.....



DESIGNED for each other and for Your Plant

. . . that's why you get more value when you buy S-E-Co.

Notice how the valve and scale fit together. The valve outlet forms part of dust-tight slip joint at scale inlet. The scale is designed to allow the valve dust cover to extend over it, not into the aisle where it is an accident hazard . . . and the whole arrangement is not only compact but built to last — and last.

In addition to coal scales and valves, the carefully designed and manufactured S-E-Co. line of products includes the CONICAL Non-Segregating Distributor; Automatic Underbunker Conveyor; Turn Counting and Paddle Type Coal Stoppage Alarms; and all other items required to make a complete, dust-tight and dependable Bunker to Pulverizer or Stoker installation.

For complete information on any S-E-Co. product write:

SPECIALISTS IN
BUNKER TO PULVERIZER AND
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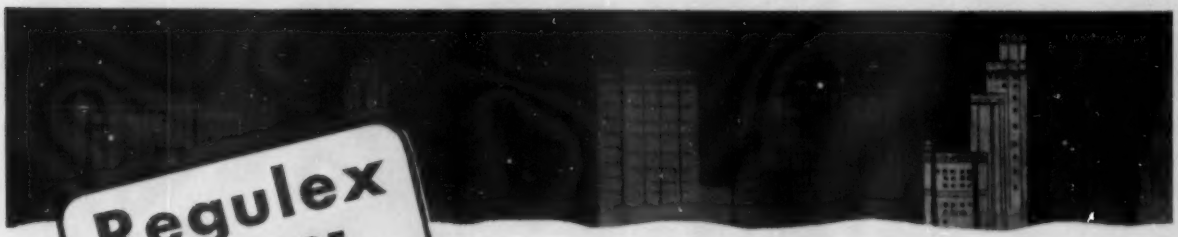


Regulex VOLTAGE REGULATORS

when loads are light

Keep Generators Stable

When the city sleeps, power demands are light. As the load drops, high power factor operation may cause generator instability.

Why *Regulex* Control?

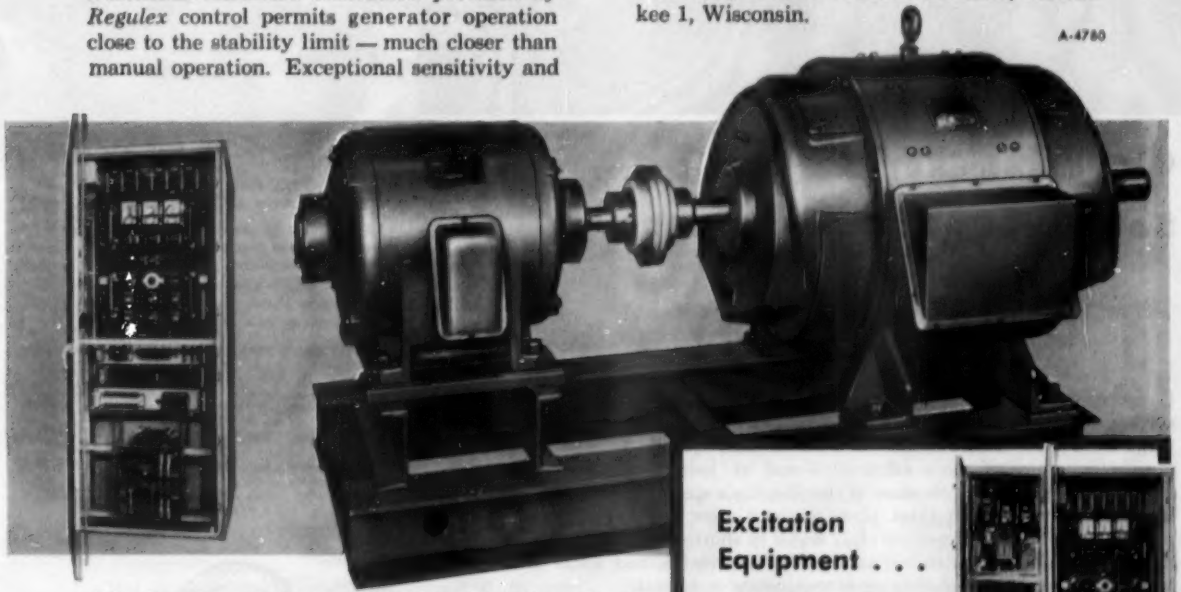
Conventional voltage regulators in power plants cut down excitation, but do not promote stability. *Regulex* control recognizes the stability problem and does not reduce excitation below the stable value.

How It Works

Automatic minimum excitation provided by *Regulex* control permits generator operation close to the stability limit — much closer than manual operation. Exceptional sensitivity and rapid response of the *Regulex* regulator and associated equipment establish and maintain a safe ratio between generator load and field current. As a result, operating limits are broadened at any power factor loading . . . proper reactive kva division is assured.

In power plant applications, *Regulex* voltage regulators may be used with alternators or synchronous condensers. No multiple special fields are required in the exciter. Get all the facts. See your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

A-4780



The *Regulex* rotating regulator consists of a motor-generator set and a cubicle containing the static regulator element. The cubicle may be installed in any convenient spot or combined with switchgear equipment. Because there are no moving parts in the static regulator element, adjustment and maintenance are eliminated.

Excitation Equipment . . .

consists of main and spare exciter field breakers in a lineup with static equipment.

Regulex is an Allis-Chalmers trademark.

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Cochrane

Solids-Contact Reactors

cut costs

Coagulation and clarification of surface waters, cold lime softening of well or surface waters, removal of alkalinity, silica, fluorides, etc., treatment of white water from paper to recover fibre and warm water are only a few of the many processes performed more efficiently—and at less cost—by a Cochrane Solids-Contact Reactor. Because of the Reactor's special "catalytic" design, the newly-formed precipitates plate out and grow rapidly—provide more complete reactions and produce clear water in shorter time, saving in size of the tanks employed. Chemical savings are impressive, and water waste is kept to a minimum. De-sludging is completely automatic.

Cochrane Corporation designs and manufactures every type of precipitation, ion exchange, deaeration and water conditioning equipment. To obtain equipment best suited to your requirements—consult Cochrane first!

For further information, write for publication 5001-A.

OIL FIELD FLOODING
AN APPLICATION OF COCHRANE REACTORS

Oil field flooding operations require water that is conditioned to prevent precipitates and suspended matter from plugging the oil-producing sandstone formations. Efficient flooding is assured by the Cochrane Solids-Contact Reactor shown above. Softening and clarification are combined in a single unit.

A FEW TYPICAL COCHRANE REACTOR INSTALLATIONS

Application	Use	Capacity gph	Size Reactor Dia.	H.
Oil Field Flooding	Softening & Clarification	350,000	1-72'0"	x19'6"
Process Water for Papermill	Softening	378,000	1-72'0"	x19'6"
Pretreatment ahead of demineralizer	Coagulation	833,400	2-82'0"	x17'0"
Process water for papermill	Coagulation & Softening	180,000	1-47'0"	x17'0"

COCHRANE CORPORATION · WATER ENGINEERS SINCE 1863 · PHILADELPHIA

Cochrane
CORPORATION

Representatives in 30 principal cities in U.S.; Toronto, Canada; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii.
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Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Continuous Blowoff Systems • Condensate Return Systems • Specialties

How much does maintenance cost?

"TOO MUCH" would be the answer of most power-service men. And that wouldn't be just an off-hand gripe—it would be a considered opinion, based on keen appreciation of two facts:

First, the biggest single element in maintenance cost is manpower. And second, manpower—particularly the skilled variety—is the most expensive item in which power-service engineers deal.

Manpower is expensive in manufacturing operations also. But in manufacturing it has been possible to boost the output of labor by mechanization and, more recently, by automation. With greater *productivity*, manufacturers can afford higher wage rates and still hold the line on product costs.

When it comes to maintenance, this line of attack has sharp limits. By its very nature, maintenance work is varied, doesn't lend itself to extensive mechanization. Sure, we can put into the hands of our maintenance men the best modern tools and methods. And we can plan maintenance to make the most efficient use of that costly element—manpower.

But if we're really going to keep maintenance costs from rising steadily or, better yet, drive them down, we've got to take a more basic approach. *We must reduce the need for maintenance.*

Progressive power-service men are doing that every day by replacing old, maintenance-eating equipment with new units that reduce and simplify upkeep. Often the possibility of drastically cutting maintenance costs is a prime incentive behind decisions to modernize.

But we're going to have to move a lot further in this direction than we yet have. To my way of thinking, the goal must be the elimination of maintenance. We may never reach that goal but we can't afford to stop trying.

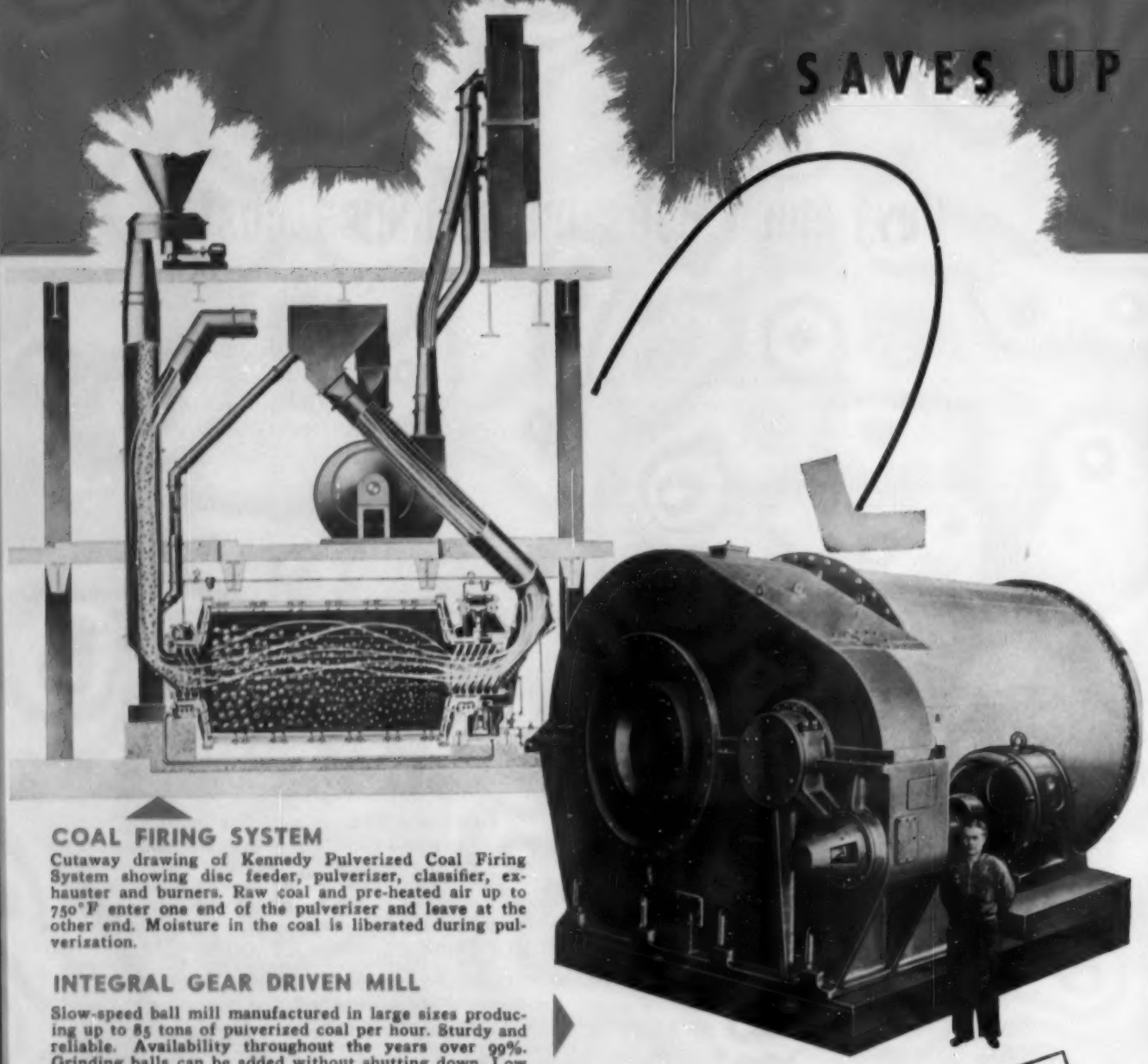
Electric motors are a good example. New insulations and improved designs give us, right now, some classes of motors that are essentially maintenance-free. They can be installed for a lifetime of operation without any attention. Such motors will, for a time at least, cost more than "minimum" designs. And some spares will be needed to replace occasional units that fail in service.

Long-run savings on maintenance justify these higher first costs in many cases. And it's my firm belief that the idea of paying today to eliminate tomorrow's maintenance will find increasing acceptance among farsighted plant managers. It must, because it's the only big ax we can swing to chop maintenance costs down to size.

THE KEN

PULVERIZED COAL

SAVES UP



COAL FIRING SYSTEM

Cutaway drawing of Kennedy Pulverized Coal Firing System showing disc feeder, pulverizer, classifier, exhauster and burners. Raw coal and pre-heated air up to 750°F enter one end of the pulverizer and leave at the other end. Moisture in the coal is liberated during pulverization.

INTEGRAL GEAR DRIVEN MILL

Slow-speed ball mill manufactured in large sizes producing up to 85 tons of pulverized coal per hour. Sturdy and reliable. Availability throughout the years over 99%. Grinding balls can be added without shutting down. Low power consumption.

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MANUFACTURING & ENGINEERING CORPORATION

TWO PARK AVENUE, NEW YORK

FACTORY DANVILLE, PA.

IT COSTS LESS.. TO OWN THE BEST!

NEDY FIRING SYSTEM

TO $3.00 PER TON ON COAL COSTS

MAXIMUM HEAT FROM PULVERIZED COAL . . .

Tremendous savings, *often exceeding $1.00 per ton,* are being realized by steam plants through the efficiency and unmatched economy of the KVS Pulverized Coal Firing System.

The KVS Coal Firing System obtains maximum heat value from every ton of coal burned. More heat means *more power* available from any given quantity of coal. No other system produces comparable results. By pulverizing coal to a fineness of 85% to 90% through a U.S. standard 200 mesh screen, maximum results are obtained.

With the KVS system, coal firing is instantaneous, combustion complete. Unburnt carbon losses held to less than ½% *at all ratings.* Pulverized fuel instantly available to meet fluctuating loads with quick, flexible response to combustion controls. Free moisture is liberated in the mill while the coal is being pulverized.

BURNS ANY GRADE OF COAL . . . CHEAPEST TO FINEST

Because of the extremely fine pulverization with the KVS Coal Firing System, the cheapest grades of coal provide complete combustion comparable to that obtained from more costly fuel. Tramp iron not only cannot damage the mill, but actually helps pulverization!

To compare your present fuel costs with the results you can expect from a KVS Pulverized Coal Firing System, estimate your unburnt carbon losses . . . figure boiler efficiency at reduced rating . . . allow for coal loss when you change rating . . . include maintenance cost on equipment

Then remember:

The KVS Coal Firing System obtains maximum heat value from every ton of coal burned.

FEATURES of the KVS COAL FIRING SYSTEM

FULLY AIR SWEPT

COAL PULVERIZED TO SUPERFINENESS

COAL COMPLETELY CARBURETED . . . Ready for combustion

BIG TRUNNIONS FOR AIR SWEEPING

BALLS ADDED WITHOUT SHUTTING DOWN

LOW OPERATING AND MAINTENANCE COSTS

UNBURNT CARBON LOSSES LESS THAN ½%

INSTANT RESPONSE TO CONTROLS

85% TO 90% THROUGH 200 MESH

20% MOISTURE REMOVED WHILE PULVERIZING

PULVERIZES ANY COAL, BITUMINOUS, ANTHRACITE, COKE BREEZE

TRAMP IRON ACTUALLY AIDS IN PULVERIZING

RESERVES OF FUEL FOR INSTANT RESPONSE AND STEAM DEMAND

GET THE FACTS ON THE KVS COAL FIRING SYSTEM!

WRITE TODAY FOR FREE BULLETIN DESCRIBING THIS EQUIPMENT!

IS DESIGN IMPORTANT IN EXPANSION JOINTS?

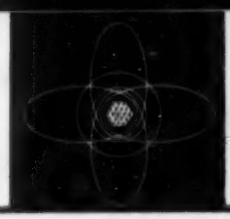
The design of an expansion joint is, to Zallea Brothers, a vital matter. Not design aimed at lowering our production costs. Not design that attempts to provide a single cure-all for every problem involving joints. Zallea design is aimed at producing the best expansion joint possible to fill a specific set of requirements —design that gives the user a superior product and the very best possible service. Actual tests have proved Zallea Expansion Joints outlast all other packless joints. Performance records like this prove superior design and construction.

Zallea design engineers are always available to help solve expansion joint problems. The best help possible is as handy as your phone or mail box. And while you're at it, request Bulletin 351—our condensed catalog of standard types. It's free. And without obligation.

Zallea expansion joints

ZALLEA BROTHERS, 814 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints



Special report from Geneva

To take POWER readers behind the scenes of the International Conference on Peaceful Uses of Atomic Energy, we present here the first-hand observations of an experienced specialist, Jerome D Luntz, editor of *Nucleonics*, who represented McGraw-Hill publications at Geneva.

FOR THE FIRST TIME we find scientists and engineers of East and West exchanging shop-talk on atomic matters that were "sensitive" before Geneva. The inevitable corridor discussions between and during formal sessions are not much different from those we indulge in at home in the U.S.

SCIENTISTS, BUSINESSMEN AND POLITICIANS each place a different emphasis on the things that interest them most at this meeting. All thinking here seems to revolve around four main questions: (1) What are the Russians showing and saying? (2) How do the U.S. and Great Britain stack up against each other in nuclear power technology? (3) What are the possibilities of getting controlled thermonuclear reactions soon? (4) Will there be a big foreign market for nuclear power equipment and atomic fuel?

RUSSIAN PRESENTATIONS here are impressive – all the more, probably, because they haven't really said anything before Geneva. Several U.S. congressmen went so far as to place Soviets second to us, ahead of the British, in nuclear technology. But scientific people don't accept this view. I don't think it's possible to make a completely accurate evaluation – there hasn't been and won't be full reporting of accomplishments at this conference. All three major nations are holding back on vital data, particularly on fuel elements.

SOVIET 5000-KW PLANT is not by any means the most advanced. They seem to be at the point we were in the U.S.A. several years ago. There is nothing unique about their pressurized graphite-moderated light-water-cooled enriched-uranium reactor. As we might expect, they do some things different from us mechanically. Their plant appears to have been put together rather quickly. AEC Commissioner Libby pointed out their reactor is inefficient in converting U-238 to Pu-239. Russians expect to improve this in a 100-mw plant they hope to have running next year, by switching from stainless steel to zirconium alloys for structural materials. This will decrease neutron loss in reactor.

BOILING-WATER REACTOR generating 15,000 kw of heat to produce 2300 electrical kw was reported by W. H. Zinn, director of Argonne National Laboratory. This test facility shows practicality of large boiling-water reactors, up to a million kw. Zinn's experiments

answered Russian argument that large reactors of this type would be unstable. It seems to me this exchange of comments showed how far behind us Russians are on boiling-water reactors.

BRITISH NEED NUCLEAR POWER BADLY and so are hitting one line of development hard. Of total needs in year 2000, they expect that the equivalent of 250-million tons of coal will be met by burning 250 tons of uranium or thorium. They are moving quickly just to get something built and operating. Despite this they expect their first plants to produce competitive 5- to 7-mill power because of credit for plutonium produced from U-238.

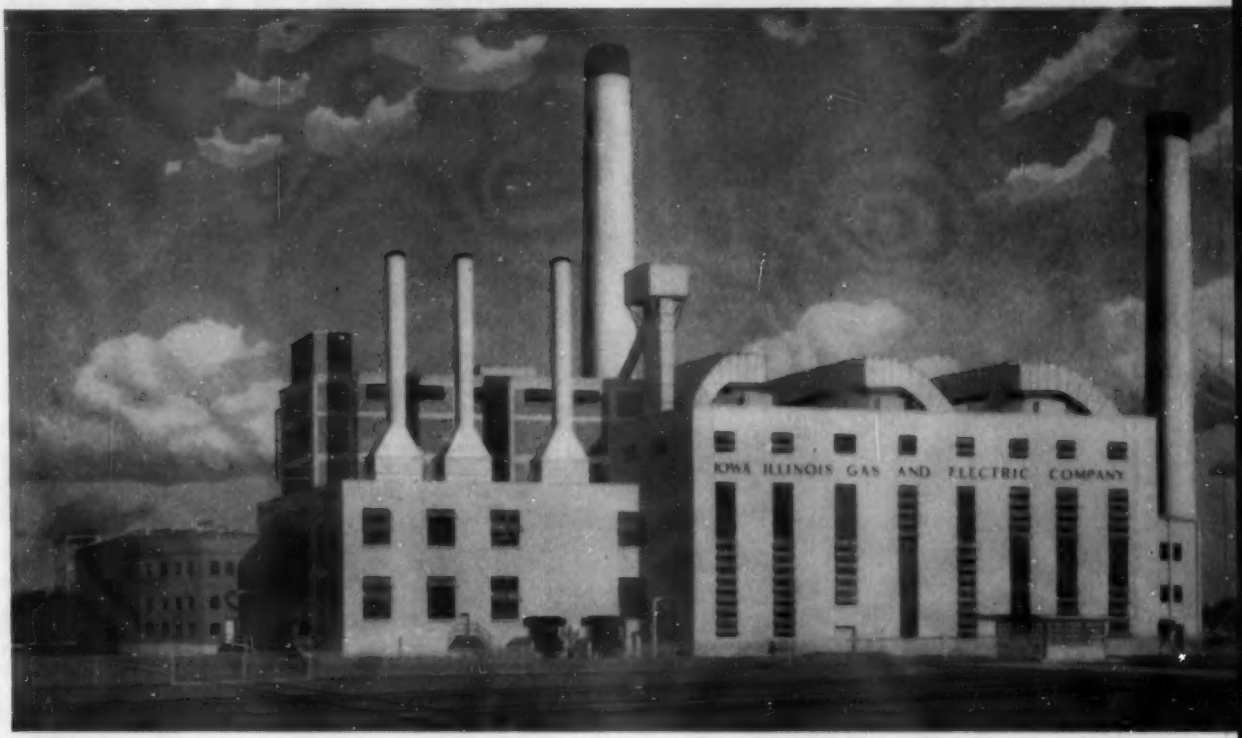
WATER-MODERATED NUCLEAR REACTORS now under study by the British show considerable promise to the extent that they are expected to succeed their graphite-moderated units. They hope power capacities will rise to at least 150 mw per reactor and expect that capital costs will drop below $250 per kw.

USING THORIUM IN REACTORS has been given a lot of attention by the British, more than in the U.S.A. One way of using it would be to build natural or slightly enriched heterogeneous uranium reactors. After extracting 3000 mw-days per ton of heat from the fuel, rearrange the fuel in the reactor so one part of the new charge consists of plutonium extracted from spent uranium, and the other part consists of thorium. In this way, fertile material in the reactor would consist mainly of thorium for all except first one or two charges – soon after, the fissionable material would be primarily U-233. A small and continuing feed of plutonium might be needed. This plutonium could be made by having small section of reactor running permanently on feed of natural uranium.

REPROCESSING SPENT FUELS has had little discussion here because of continued secrecy in this area of nuclear power. For example, the Russians have no papers of significance on this topic in the program. Our country, however, is showing in its elaborate official exhibit a model of Idaho Chemical Processing Plant – it's the first time we have shown anything about the plant in public. U.S.A. also has an operating model of uranium processing techniques used in chemical separation of radioactive materials. Demonstration includes separation of uranium from copper by solvent extraction, concentration of uranium by ion exchange, remote sampling and analysis of uranium and sodium-nitrate solutions.

CONTROL OF THERMONUCLEAR REACTION was deliberately kept off conference agenda. But it has been the principal subject of discussion at press conferences and in corridors. After Conference President Homi Bhabha of India predicted, in his opening address, that fusion reactors would be possible in next two decades, reporters forced both U.S.A. and U.K. delegations to acknowledge doing work in this area. With this first public admission, the officials would not guess when controlled fusion could be expected – nor tell how they are approaching the problem.

B G A SKROTZKI
Associate Editor in Charge



MOLINE STATION after modernization was completed and building volume per kw capability reduced from 43.75 to 22.86 cu ft

Modernizing ups generating capacity, holds down kw cost

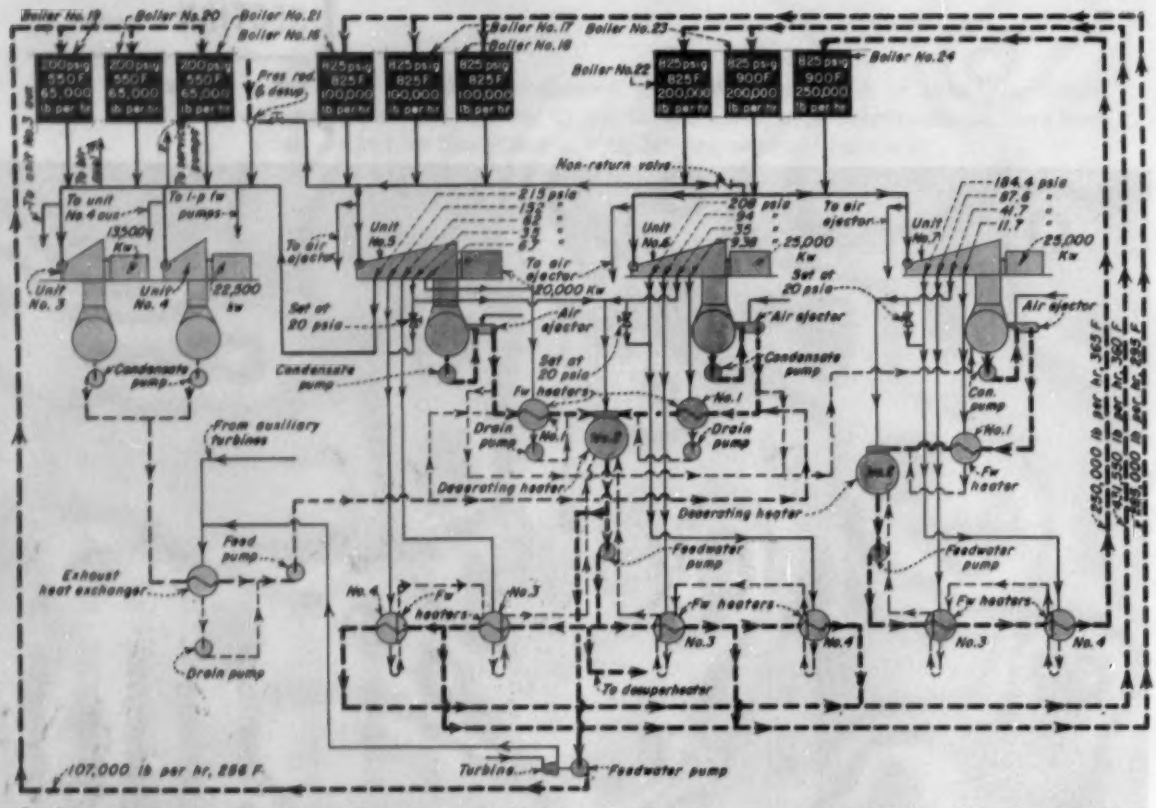
How Iowa-Illinois Gas & Electric Co modernized its Moline Station, increased plant capability from 53,000 to 110,000 kw at $125 per kw installed and reduced heat rate 24%. This outstanding achievement won a *Power* 1954 modernization award

Power MODERNIZATION PROGRAM

A 1954 AWARD WINNER

► THE COMPANY'S TWO PLANTS, Riverside and Moline Stations, supply a highly industrialized area known as the Quad-Cities, which includes Rock Island, Moline and East Moline, Illinois, and Davenport, Iowa. Riverside Station, with 140,900-kw installed capacity is a fairly modern and efficient plant, using steam pressures up to 850 psig and temperatures up to 900 F.

Moline Station is near the center of the farm-implement manufacturing industry of Moline. In 1950, this plant housed four turbine-generators with a one-hour capability of 53,000 kw, as shown on the following page:



1 Steam, feedwater and condensate flow diagram for Moline Station after being modernized. Feedwater-heating system supplies water at temperatures of 256, 295, 360 and 365 F, as dictated by thermal needs for efficient plant operation

Unit No. 2, rated 2 phase, 6400 kw, 200 psig, 500 F, went into operation in 1906.

Unit No. 3, a 12,000-kw, 200-psig, 500-F turbine-generator installed in 1913, was rewound in 1950 for 15,000 kva, 13.8 kv, 3 phase.

No. 4, a 20,000-kw, 200-psig, 500-F turbine-generator, was installed in 1918. In 1950, its generator was rewound for 25,000 kva, 13.8 kv, 3 phase, and its turbine was rebladed and renozzled for 200 psig and 600 F.

No. 5, a 17,143-kw, 825-psig, 825-F turbine-generator, installed in 1942, was designed to permit extracting from it 200,000 lb per hr into the 200-psig steam header that supplied turbines No. 3 and 4.

These units were supplied with steam from ten boilers (No. 6 to 15) 25,000 lb per hr, 200 psig, 525 F, gas and oil fired, installed in 1906-07; three boilers (No. 19 to 21) stoker fired and rated 65,000 lb per hr, 225 psig, 525 F, installed in 1918; three boilers (No. 16 to 18) rated 100,000 lb per hr, 825 psig, 825 F, are spreader-stoker and gas fired and were installed in 1942-43.

Interconnection. Riverside and Moline plants are connected electrically by two 66-kv lines and through a 13.8-kv network so that generation at them could be regulated for the most economical operation as required by the Quad-Cities area. At least one unit was kept in service at Moline Station during periods of light loads to insure service to the Illinois area.

Normally, Moline Station operated as a peak-load plant and as a reserve for the load-carrying units in Riverside. Spreader stoker-fired boilers in Moline were well adapted for this type of service since they could be banked for long periods without loss of ignition and pickup load during peak periods on reasonably short notice. Quad-Cities power system is also interconnected with three other utility companies in Iowa and Missouri as a participant of the United Power Pool.

Modernizing program. Studies made of the company's system load in 1950 showed that more capacity would be required by the end of 1953. Of several investigated plans to meet load growth, modernizing Moline Station proved the most economical. This plan included:

1. Take out old boilers No. 6 to 15.
2. Remove turbine-generator No. 2.
3. Install boilers No. 22, 23 and 24, Fig. 1.
4. Install two 25,000-kw turbine-generators, No. 6 and 7.
5. Build boiler room No. 3.
6. Develop part of boiler room No. 1 into a service building.
7. Rebuild feedwater heating system and make other necessary changes in the plant.

Boilers No. 6 to 15 had served their economical life and should be removed, but operating capacity of the plant would then be reduced from 53,000 to 37,000 kw. Probably long-range effect of this would be to retire the plant after the remaining equipment had served its economical life.

Because operation of Moline plant would help insure continuity of service in this area and its turbine-generators had been recently rebuilt and modernized, replacement of the retired boiler capacity proved economical. To develop full turbine capacity required an investment in boiler equipment only.

2 Turbine-generator plant has five units rated 13,500 to 25,000 kw. Turbines 3 and 4 operate on 200 psig, 550 F. No. 5 uses 825 psig, 825 F, and extracts at 5 points; 6 and 7 are designed for 825 psig, 900 F and 4-points extraction

Modernization studies included the possibilities of using existing turbine-room space for new generating capacity. In addition to turbine-room space, this site also had the advantages of two existing concrete chimneys, circulating-water facilities, yard trackage, coal-handling equipment and coal-storage capacity. Offsetting the economic advantage of existing facilities, available space in the turbine room limited the capacity of the unit to 25,000 kw, so selection of this unit and a 200,000-lb-per-hr gas-oil-fired boiler represented the most economical installation.

These units were ordered during the first part of 1951. The second 200,000-lb-per-hr 825-psig 825-F gas-oil-fired boiler, modified for future operation at 825 psig, 900 F, was also ordered. This equipment shows on Fig. 1 as boilers No. 22 and 23 and turbine No. 6. Late in 1952, boiler No. 22 went into service, increasing the station's one-hour capability to 64,262 kw. In June 1953, when boiler No. 23 and No. 6 turbine started operation the plant's capability was increased to 83,000-kw generator capacity.

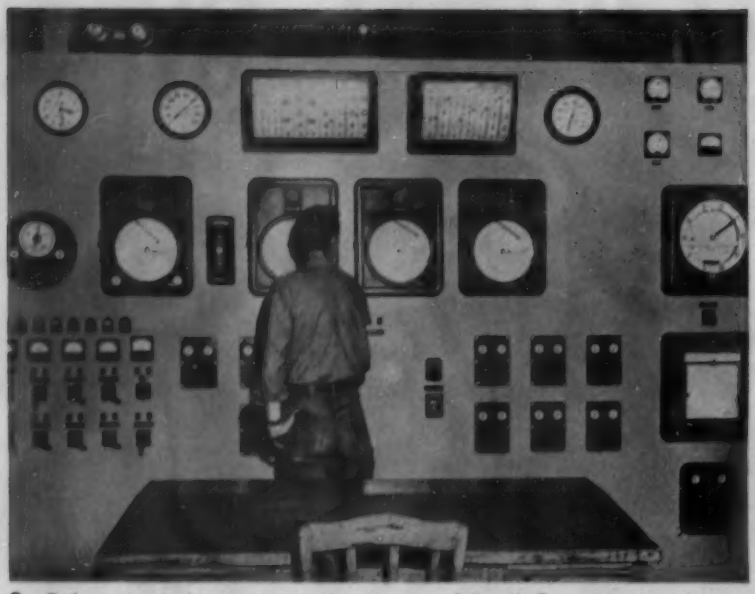
Coal burning. These gas-oil-fired boilers were designed for future installation of coal-burning equipment. This decision was based on a study that showed the capital saving, made by deferring the coal-burning equipment investment, would exceed the increase in fuel cost resulting from burning oil when gas might be curtailed during the immediate future. When increased cost of burning oil—with gas unavailable—exceeds the capital charges on the investment for coal-burning equipment, it will be installed.

More generating capacity. Additional studies showed that more generating capacity would be needed in the Quad-Cities area by the end of 1954. Because of high operating and maintenance costs of the 6400-kw unit, its removal was desirable as in its space a modern 25,000-kw unit could be installed. After studies showed that this unit would be a better investment than a 40,000-kw one in Riverside Station, a third 25,000-kw turbine-generator, No. 7, and a 250,000-lb-per-hr 825 psig 900-F gas-oil-fired boiler, No. 24, were ordered for Moline.

Putting a nonreturn valve in the 825-psig steam header, when unit No. 6 and boiler No. 23 were installed, permits operating units 6 and 7 at 825 psig, 900 F from boilers 23 and 24. Boilers 22 and 16 to 18 supply 825-psig 825-F steam for unit No. 5 direct. Units 3 and 4 take steam from the 200-psi extraction point of unit No. 5, also through a pressure-reducing and desuperheating station, Fig. 1, on the 825-psig header.

Studies showed that the fuel savings resulting from the 75-F increase in throttle conditions of units 6 and 7, which required increasing No. 24 boiler capacity from 200,000 to 250,000, decreased the heat rate of these units about 2.6%. This increased the accredited capacity of the station 5000 kw. Evaluating the fuel saving against the increase in capacity showed that the additional investment would be returned in about 2 1/3 years. When this equipment went into operation late in 1954, the gross one-hour capability of Moline Station became 110,000 kw, more than double that of the plant when the modernization program started.

Structures. Since units 6 and 7 used



3 Boiler-meter and automatic-combustion control board. From this, operator can make the necessary adjustments to hold boiler operation close to test performance

existing space in the turbine room a new boiler room was the only building needed in the project. Space for boilers 22 and 23 was obtained by removing the center section of the brick building that housed boilers 12 to 15. Built with a reinforced concrete substructure and a Galsbestos-clad structural-steel superstructure, volume of the building was kept to a minimum by putting the forced- and induced-draft fans on the roof. Even though adequate space has been provided for installing a coal bunker, spouts, scales, ash-handling equipment and pulverizers at a future date, the building's volume of 516,000 cu ft is about 1.29 cu ft per lb of steam capacity (normal rating).

Housing for boiler No. 24 contains 240,000 cu ft, or about 0.96 cu ft per lb of steam capacity (normal rating), and has space for future coal-handling and burning equipment. Forced- and induced-draft fans for this boiler are also on the roof. Minor changes were made in the turbine room to provide for turbine foundations and auxiliary equipment. It was also necessary to make changes in one wall of the turbine room to permit removal of No. 7 generator rotor. Modifications and new capacity additions at Moline Station reduced building volume per-kw capability from 43.75 to 22.86 cu ft per kw.

Feedwater system. When boiler No. 23 and unit No. 6 were installed the feedwater-heating cycle was modernized. Before this the heating equipment for the 200-psig units contained three open heaters using exhaust steam from turbines driving feed pumps and other boiler auxiliaries. Feedwater temperature ranged from 170 to 212 F depending on the electric load on the 200-psig units. For unit No. 5 the feedwater-heating cycle had two low-pressure closed heaters. No. 1 heater extracted steam from the turbine, while No. 2 heater used exhaust from a 825-psig turbine-driven feed pump, for a final feedwater temperature of 230 F.

Since units 3 and 4 are not designed for heating steam to be extracted from them, the redesigned feed system uses steam from turbines 5 and 6 to heat feedwater for the 200-psig boilers as well as for their own boilers. Condensate from the 200-psig units goes through a heat exchanger where it condenses exhaust from steam-driven auxiliaries and enters the feedwater cycle at No. 1 heaters of units 5 and 6. Feedwater goes to the 200-psig boilers at 256 F after passing through No. 1 heater and a direct-contact deaerating heater, Fig. 1. Feedwater for boilers 16 to 18 is pumped through No. 3 closed heaters and to the boilers at 295 F. Remaining feedwater passes through No. 4 heaters of units 5 and 6 before going to boilers 22 and 23 at 360 F.

Unit No. 7 uses a 4-heater feedwater-heating cycle that gives a final water temperature of 365 F, before entering boiler No. 24. No. 2 heater in this system is a direct-contact deaerating design, while the others are vertical closed type.

Evaporators. Since boilers 6 to 15 served as evaporators to supply makeup to the 825-psig system, a 25,000-lb-per-hr evaporator was installed with unit No. 6. Vapor from this evaporator discharges into the deaerating heater where it condenses and enters the feedwater system.

Level in the deaerating heater's storage tank is regulated by valves that automatically control condensate flow in and out of an 85,000-gal pure-water well. Steam for the evaporator coils comes from the 200-psig header or an extraction point on No. 6 turbine. Shell pressure is held at 45 psig by a back-pressure valve, regardless of the evaporator load, to reduce carryover.

A second 25,000-lb-per-hr evaporator was included as part of the auxiliary equipment for unit No. 7. Vapor from this evaporator enters the deaerating heater serving unit No. 7, condenses and goes into the feedwater cycle.

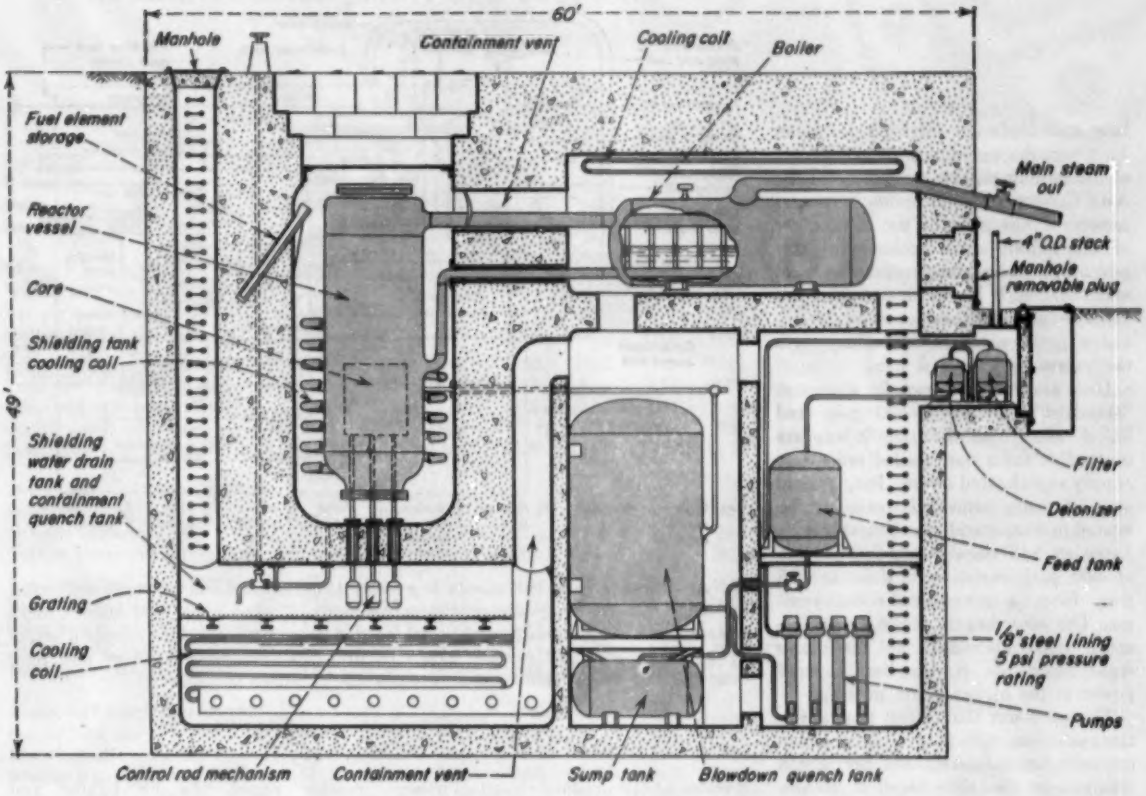
Modernization results. Moline Station was built when new capacity cost $100 per kw or less. Before modernizing, the 53,000-kw capacity meant a $5,146,000 investment, or $97 per kw. If the station had not replaced the ten old 200-psig boilers and the capacity they represented, the resulting 37,000 kw would have showed an investment of $4,871,000, or $131 per kw.

Installing boiler 22 increased the station's one-hour capability to 64,262

(*Continued on page* 190)

Summary of Moline Station capabilities, 1950 and 1955

Equipment	Capability, kw	Investment, $	Cost per kw, $	Station heat rate, Btu per kw hr, net
Moline Station, 1950 less boilers 6 to 15	37,000	4,870,900	131	18,233
Add boilers 22 to 24, turbine-generators 6 and 7	73,000	8,851,661	121	11,877
Moline Station, 1955	110,000	13,722,561	125	14,137



1 Closed-cycle boiling-water reactor depends on natural convection to circulate steam and water between reactor vessel and boiler. Entire containment shell for plant reactor is contained within the surrounding concrete biological shield

Here's how nuclear energy promises to serve the small central station at costs that could be competitive. This study examines plants of 10- to 20-mw capacity with and without separately fired superheaters supplying steam from a . . .

Closed-cycle boiling-water reactor

By G I STABER, *Technical Director, Atomic Energy Division,*
and F H HOLZER, J MacPHEE, *Nuclear Products Section, General Engineering Laboratory, AMF Atomics, Inc.*

► WE STUDIED designs of nuclear power plants to find one suitable for a 10- to 20-mw rural installation. The plant should possibly be built in the near future with a minimum of research and development needed. Limited by location and size of operating force, the plant should also be simple with a minimum of maintenance and operating problems to keep costs low.

We believed originally that a "conventional" pressurized-water reactor would be best. Making a general survey of reactor types, we came to these conclusions:

1. *Gas-cooled reactor and gas turbine* —appears to have long-range possibilities, but development problems in radioactive gas-turbine circuit rule it out for small plant.

2. *Liquid-metal-cooled reactor and steam turbine*—complexities of handling highly reactive liquid metals make it unsuitable for small plant.

3. *Pressurized-water reactor and steam turbine*—appears entirely suitable if it can be economically justified.

4. *Boiling-water reactor and steam turbine* — development problems and maintenance troubles in radioactive tur-

bine and feedwater circuit rule it out. To retain the economics and simplicity of the boiling reactor we conceived the AMF CLOSED-CYCLE BOILING-WATER REACTOR—it has most of the advantages of the boiling cycle without the disadvantages, also simple operation and maintenance. It has some operating advantages of its own and, most important, has a great economic advantage over the pressurized-water design.

One aim was to supply steam at "standard" conditions—600 psig and 825 F at turbine throttle. It appears impossible for a watercooled reactor to supply superheated steam. But, if economy warrants, saturated steam can be heated in a separately fired superheater. Later we will show power from steam at 600 psig costs more than at 235 psig from a pressurized-water reactor. The closed-cycle boiling-water reactor (CCBWR) does not have this disadvantage — it supplies cheaper power at the higher steam pressure.

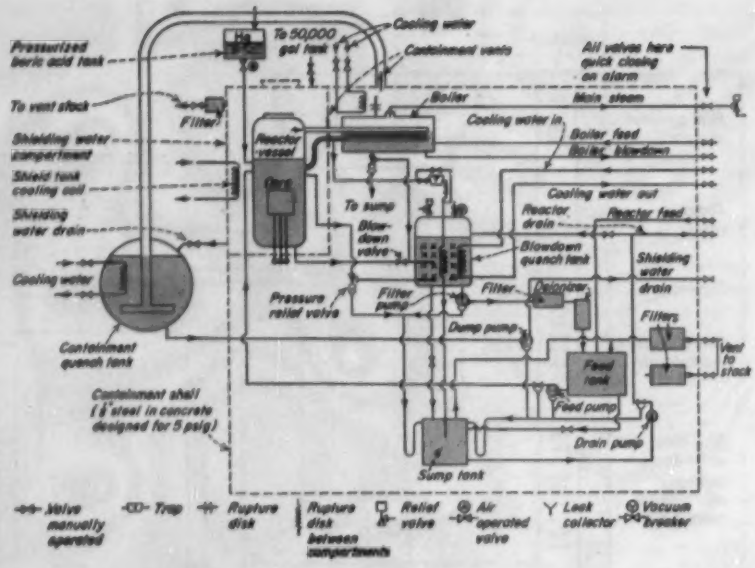
Though lower than latest central-station practice, 600 psig is a common pressure for industrial and propulsion turbines in the sizes studied. Hence, the reactor may replace existing boilers and, except for the separately fired superheater, doesn't require revamping the rest of the power plant.

For many plant designs, containment becomes a major cost factor. The design in Fig. 1 gives a sealed plant, totally contained at minimum cost. Indeed, eliminating the containment in this design would make only a negligible saving in first cost. All components of the plant have been selected for minimum first cost and simplicity, and utmost safety.

We show here estimates of first and operating costs of 21 reactor plants out of a total of 30 that we studied, see table, opposite page. Basic nuclear fuel costs, being classified, must be omitted from this report. We estimated nuclear-fuel costs from all available information and believe them to be realistic. These costs form the basis of all reactor costs compared here.

The striking economic advantage for the CCBWR found in our study was not obtained by juggling fuel in the reactor core. The advantage comes from a straightforward improvement of over-all thermal efficiency and reduction of first cost by simplification of mechanical design.

Study shows that a 20-mw electric plant working at 80% load factor and paying capital-cost rate of 15% on its investment can produce electrical power for a total cost of 8 to 10 mills per kwhr. While not competitive with large central stations this cost compares favorably with smaller central stations and many industrial plants of the same size. We believe the CCBWR is practical for immediate application in many parts of the U.S.A.



2 Absence of valves and pumps in primary loop between reactor vessel and boiler helps to prevent leakage of radioactive fluids. Cooling water and quench tanks reduce the size of containment vessel needed in reactor accident releasing radioactive fission products. Primary loop runs at 1200 psig, boiler shell at 650 psig; quench tanks and containment shell designed for 5-psig pressure

Our study assumes a saving in both first cost and operating cost will be made after experience with the first one or two CCBWR built and operated. We feel this allowance is conservative and reasonable. But no credit is taken for future reductions in nuclear-fuel costs. Undoubtedly nuclear fuel costs will drop markedly in the next 10 years. If so, the minimum total power costs shown in this report will decrease also.

REACTOR LAYOUT

The plant, Fig. 1 and 2, consists of a boiling heterogeneous reactor, a primary heat exchanger, and auxiliaries necessary for supplying saturated steam at 600-650 psig. This plant has these advantages over the pressurized-water reactor (PWR):

1. No pumps or valves in the primary loop which is much smaller—making a great saving in first cost and maintenance.

2. Lower primary system pressure for given temperature. Primary piping and reactor vessel can be lighter and cheaper.

3. High heat-transfer rates and more effective use of heat-transfer surface.

4. Compared to "conventional" boiling reactor, there are no radioactive fluids in turbine and boiler feed circuit —can use standard maintenance methods.

5. Heat capacity of primary heat exchanger adds lag (flywheel effect) to system—relaxes requirements on control system.

A concrete block about 16 ft wide, 60 ft long and 50 ft deep encloses the entire 20-mw (electric) nuclear steam plant—largely underground. On top of this a simple structure (weather protection only) has a monorail that extends out one end to handle fuel casks.

Auxiliaries within the containment structure can be serviced during reactor operation—entering via air lock with hose ventilation if desired. All pumps and valves will be a maximum distance from the reactor for ease in servicing. After initial start-up, however, this area will be entered rarely. Enough remotely operated spares will be provided so that servicing will be done normally during reactor shutdown only.

Reactor and vessel. The reactor uses zirconium-alloy cladded natural-uranium fuel elements. Enriched-uranium fuel elements, similarly clad, spike the core. Power density equals 20-30 kw

Nuclear reactor plants and cost data

	(1) Mod APPR	(2) Press. water	(3) Press. water supht	(4) AMF CCBWR	(5) AMF CCBWR supht	(6) AMF CCBWR D_2O	(7) AMF CCBWR D_2O supht
Reactor pressure, psig	1200	2000	2000	1200	1200	1200	1200
Reactor temperature, F	450	547	547	567	567	567	567
Steam pressure, psig	235	630	600	630	600	630	600
Steam temperature, F	sat	sat	825	sat	825	sat	825
10-MW NET ELECTRICAL OUTPUT							
Reactor size, mw	50	42.3	29.8	41.5	28.5	41.5	28.5
Net plant efficiency, %	20	23.6	26.1	24.1	27.3	24.1	27.3
Nuclear steam gen cost, $1000	4440	4905	4395	2705	2540	2980	2785
Turboelec plant cost, $1000[a]	1200	1100	1200	1100	1200	1100	1200
Total fuel cost, mills/kwhr[b]	4.12	3.52	3.33	3.50	3.25	3.23	3.06
Labor and maint, mills/kwhr[c]	2.52	2.52	2.61	2.52	2.56	2.54	2.61
Capital costs, mills/kwhr[d]	12.10	12.85	11.92	8.15	7.98	8.72	8.54
Total power cost, mills/kwhr[e]	18.74	18.89	17.86	14.17	13.79	14.49	14.21
15-MW NET ELECTRICAL OUTPUT							
Reactor size, mw	70	59.5	41.6	58.8	40.6	58.8	40.6
Net plant efficiency, %	21.4	25.2	27.9	25.5	28.7	25.5	28.7
Nuclear steam gen cost, $1000	4895	5245	4795	2830	2670	3105	2915
Turboelec plant cost, $1000[a]	1550	1450	1600	1450	1600	1450	1600
Total fuel cost, mills/kwhr[b]	3.85	3.23	3.12	3.32	3.10	3.05	2.91
Labor and maint, mills/kwhr[c]	1.88	1.88	1.95	1.83	1.90	1.88	1.95
Capital costs, mills/kwhr,[d]	9.26	9.55	9.10	6.11	6.08	6.50	6.43
Total power cost, mills/kwhr[e]	14.99	14.66	14.17	11.26	11.08	11.43	11.29
20-MW NET ELECTRICAL OUTPUT							
Reactor size, mw	89.4	77.9	53.3	74.6	51.7	74.6	51.7
Net plant efficiency, %	22.4	25.7	29.0	26.5	30.1	26.5	30.1
Nuclear steam gen cost, $1000	5455	5815	5065	2990	2770	3265	3015
Turboelec plant cost, $1000[a]	1800	1700	1900	1700	1900	1700	1900
Total fuel cost, mills/kwhr[b]	3.68	3.16	2.99	3.12	2.95	2.91	2.78
Labor and maint, mills/kwhr[c]	1.54	1.54	1.62	1.49	1.57	1.54	1.62
Capital costs, mills/kwhr[d]	7.75	8.05	7.48	5.00	4.98	5.31	5.25
Total power cost, mills/kwhr[e]	12.97	12.75	12.09	9.61	9.50	9.76	9.65

[a]—Includes cost of separately fired superheater

[b]—80% load factor. Includes burn-up, fabrication and reprocessing and 4% interest charges on nuclear fuel plus superheater fuel at 30¢ per million Btu; 85% superheater efficiency

[c]—80% load factor. Two operators per shift at reactor plus normal turbine-plant operators

[d]—Interest, taxes, amortization, insurance computed at 15% of investment not including fuel charge; 80% load factor

[e]—80% load factor. Costs are for first one or two plants. Subsequent similar plants will have reduced costs; see Fig. 3 to 9 for estimates.

per liter and average heat flux is less than 100,000 Btu per hr per sq ft. At 1200 psig the burnout heat flux is greater and the required vapor fraction to remove this amount of heat is smaller than at lower operating pressures.

Water in the reactor boils at 567 F. Under the low heat flux in the reactor and the favorable heat-transfer conditions the maximum surface temperature of the fuel elements will not exceed 580 F. To run at lower fuel-element temperature, the reactor pressure may be dropped several hundred psig without prohibitive penalty because of a larger primary heat exchanger.

Steam from the reactor flows to the tube-side heat-transfer surface in the primary heat exchanger. There it condenses and returns by gravity to the reactor vessel. Natural convection produces circulation within the reactor pressure vessel.

The reactor vessel and all other high-temperature parts exposed to shielding water will be thermally insulated.

Boiler, or primary heat exchanger, will be a drum (650 psig) containing heat-transfer surface made up of a large number of short vertical tubes containing the condensing steam from the reactor, working at 1200 psig. We believe this arrangement gives maximum heat-transfer rates. In addition, the vertical tube arrangement enhances the scheme for maintaining constant steam pressure at all loads.

Varying the water level in the boiler drum maintains the steam pressure constant in the secondary system. This varies the effective heat-transfer surface so plant-load variations can be accommodated without affecting pressures and temperatures in primary and secondary steam loops.

Operating shell side and tube side at constant temperature minimizes the thermal stress problem. This means the boiler shell need be designed for a working pressure of only 650 psig.

To keep heat-exchanger fouling to a minimum, highly demineralized water flows in both primary, secondary loops

AUXILIARIES

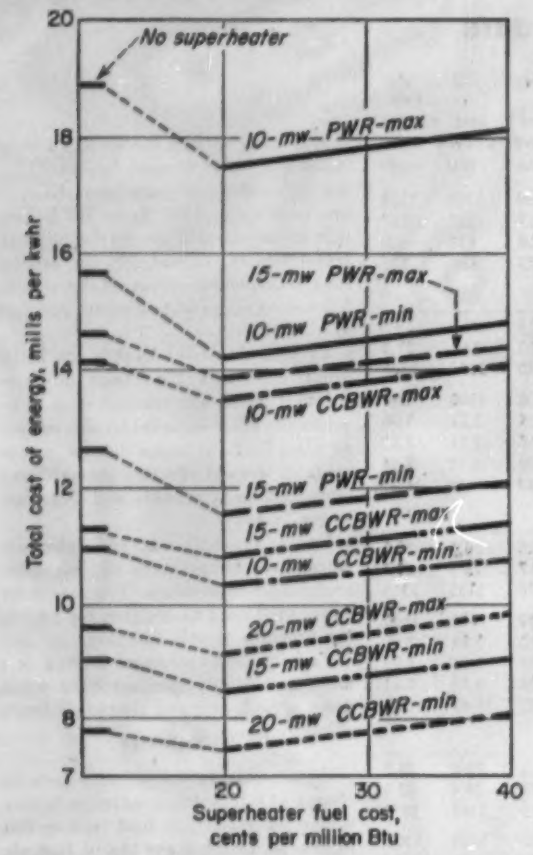
Connections to the primary loop include: (1) blowdown outlet to bottom of reactor vessel (2) feed inlet to side of reactor vessel above top of fuel elements (3) pressure relief line to side of reactor vessel above top of fuel elements (4) noncondensable gas vent on lower header of primary heat exchanger.

Blowdown line from reactor vessel goes through standard blowdown valves into blowdown quench tank. This tank, half filled with water and chemical packing, contains a coil, to cool the water low enough to condense flash steam. Tank design depends on pressure-relief needs discussed later.

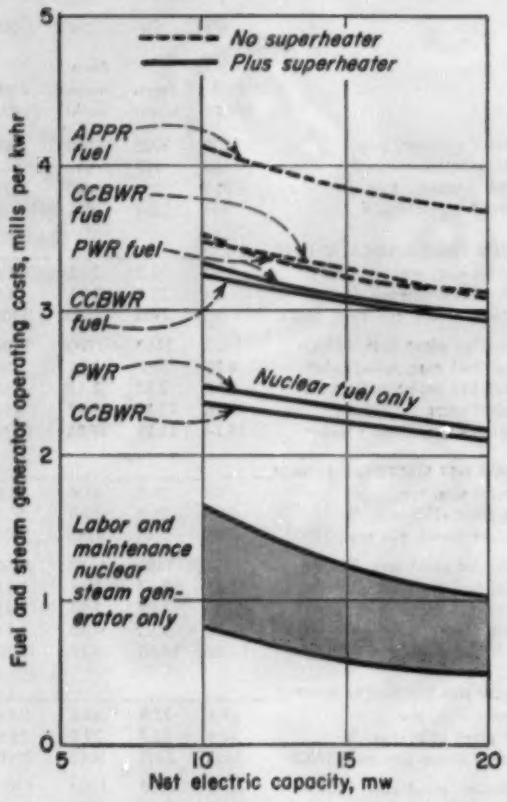
Purification. Circulating pump, filter and demineralizer remove suspended and dissolved impurities from the primary water. This system takes its suction from the blowdown quench tank and discharges to the feed tank. Constant recirculation through the demineralizer gives continuous purification. When operating this way, the reactor vessel would be blown down periodically with a corresponding amount of makeup added from the feed tank.

Feed system. Feed tank inside the containment shell stores feedwater for the entire shell. A pump transfers feedwater from the tank to the system. A 50,000-gal storage tank above ground will supply demineralized water to the shield tank. Fuel-loading operations require this large amount of water.

Drains and vents. Blowdown quench



3 Separately fired superheating of steam in reactor plants usually reduces over-all cost of plant kwhr output. As the superheater fuel cost rises, the over-all kwhr cost rises and eventually wipes out the advantage of the additional heating. Superheater efficiency figured at 85%, load factor at 80%



4 Fuel (nuclear and fossil) costs and labor and maintenance costs on nuclear steam generator decrease per kwhr output as station capacity grows. Nuclear-fuel cost includes burn-up, fabrication and reprocessing plus a 4% interest on fuel inventory. Superheater fuel figured at 30¢ per million Btu

Combining fossil-fuel firing with nuclear fuel shows advantages

tank, feed tank and all leak collectors drain to the sump tank. Liquids in the sump tank can be pumped back into the blowdown quench tank or through a line leading outside the containment shell.

The line removing noncondensable gases from the primary heat exchanger passes through standard impulse-type traps, through the cooling coil in the blowdown quench tank into the sump tank. Gases in the sump tank vent through a filter up a stack to atmosphere. This vent stack will be a 4-in. guyed pipe extending about 75 ft above grade. If needed, a refrigerated cold trap could be added to this vent.

The containment shell also connects to the vent stack through a filter. This allows for air expansion and contraction from normal temperature changes. The vent also discharges air displaced when filling the shield tank before opening the containment shell.

The shield tank drains to the containment quench tank. The latter tank empties by pumping the water through a line leading outside the containment shell.

Valves and pumps. Standard commercial pumps and valves for heavy-duty service will be installed in duplicate, or triplicate, in parallel or series as needed for continuity of operation and minimum maintenance within the containment structure.

Both bellows-sealed and packed valves, as well as packed and rotary-sealed pumps, will be used. Vertical-shaft deepwell-type pumps will be selected for leak tightness and dependability. No effort will be made to reach the ultimate of no possible leaks at valve stems or pump shafts. Of course, the reactor vessel, primary circuit and all potentially radioactive piping will be fabricated, inspected and tested for absolute tightness.

Valves will be operated through extension stems at the operating floor level outside the containment structure. Mechanical interlocks, and locks, will prevent misoperation.

Cooling system. Cooling coils, in the shield tank, containment quench tank, blowdown quench tank, and at a high point in the containment-structure atmosphere, will maintain a reasonable ambient temperature. This allows proper electric motor operation and

prevents damaging the concrete. Some of these cooling coils will operate during loading operations to hold shielding water at a reasonable temperature.

It will not be necessary to enter the containment shell during normal operation. No permanent ventilating equipment will be installed. During servicing operations temporary hose ducts will supply ventilating air.

CONTROL

Experiments, such as Borax, have proven that a boiling reactor is stable when run at constant pressure. But coupling such a reactor directly to a turbine or through a heat exchanger, as in this case, may cause large excursions in reactor power and pressure with load variations. Calculations show that at design conditions this reactor has a negative power coefficient, minimizing pressure and power excursions. Even so, intolerable pressure excursions would be experienced in response to changes in turbine load if no control system were provided for this plant. So we propose to operate the plant at constant primary steam pressure (1200 psig) and constant secondary steam pressure (600 psig). Aside from stability, this has other advantages pointed out under "Boiler" p 77.

Varying the water level in the shell side of the boiler varies the effective heat-transfer surface and controls the secondary steam pressure. An element sensing secondary-steam pressure signals a boiler-level control system that regulates rate of feedwater flow to the boiler. For example, a drop in steam pressure raises the boiler-water level to increase steam production.

Increasing turbine load drops the secondary steam pressure and increases the steam flow. Steam-flow measurement serves as an anticipatory signal in the control system, improving the response.

Reactor steam pressure is controlled independently of the secondary loop. The control rods move in response to a signal representing reactor pressure. As in the secondary loop, steam flow provides an anticipatory signal to improve response. Decrease in reactor pressure causes the control rods to be moved out of the core and a pressure increase causes them to be reinserted.

The added heat capacity of the primary heat exchanger tends to dampen variations in secondary steam pressure that reflect back into the primary loop of the reactor.

Worst load variation anticipated is the sudden loss of full turbine load. This will automatically open a dump valve and trip off the superheater. Dumped steam flows to the main condenser. This arrangement may also be used to remove residual heat from the reactor.

Components. We expect to use conventional control-system components. We have carried out extensive development programs on rod-drive mechanisms for pressurized water reactors. The same design principles can be used for this reactor. Control console and instruments will be on the concrete floor above the boiler.

SAFEGUARDS

This plant is not a hazard to the surrounding countryside because any energy released in an uncontrolled manner will either be confined to the plant enclosure or else removed at a safe rate.

The reactor can be shut down under all conditions, either by the control rods, or by an emergency injection system described later. The worst possible accident would be a system rupture with an almost instantaneous energy release on the order of 200 mw-sec. This energy release would be contained and dissipated by the plant structure.

Under certain conditions an additional amount of energy could be released over a comparatively longer time —the energy from fission-product decay (decay heat). We intend to design the cooling coils within the containment shell to remove this additional heat.

Containment, pressure relief. The reactor, boiler, and all primary loop components are sealed in a welded-steel shell buried in concrete. These are designed to contain an internal pressure of 5 psig. The containment quench tank and shield tank will be corrosion resistant. A rupture disk designed for 2 psig isolates the shield tank from the rest of the containment shell. This prevents Argon-41 in the air above the shield water from contaminating the rest of the containment shell during normal operation.

If the primary loop ruptures, water and steam will fill the shell. The containment quench tank connects to the containment shell through a 3-ft-dia vent. This tank has enough water to hold the steam pressure after rupture to not more than 5 psig.

A pressure-relief line leads from the reactor vessel through a relief valve to the blowdown quench tank. This is a backup for the scram system, which should normally scram the control rods in event of overpressure. If reactor and primary loop pressure should rise over the scram point, the spring-loaded relief valve opens and allows the reactor water to discharge into the blowdown quench tank. As the pressure in the reactor drops, the vapor fraction increases, which will tend to shut down the reactor.

The blowdown quench tank, with its water and ring packing to distribute flash steam, accommodates a 5-ft decrease in reactor water level without increasing pressure above 5 psig. A safety valve discharging into the containment shell relieves pressures greater than 5 psig. This tank will be designed for 5-psig working pressure.

A conventional safety valve outside the containment shell normally relieves excess boiler pressure. But, if a heat-exchanger tube should rupture and excess radioactivity enter the steam, a monitoring device shuts a quick-closing valve between the boiler and standard safety valve. Another relief valve, set for a higher pressure, then opens and discharges into the blowdown quench tank. As the ultimate relief, a rupture disk equipped with a safety valve set for a still higher pressure on the boiler drum can discharge within the containment shell.

If an accident releases fission products, all valves in lines leading outside the containment shell will be automatically closed by monitoring devices. The removable metal cover over the reactor will be sealed in place with molten lead. The shielding blocks over the metal cover will be heavy enough to resist 5 psig so that it will not be necessary to design the removable metal cover as a pressure closure.

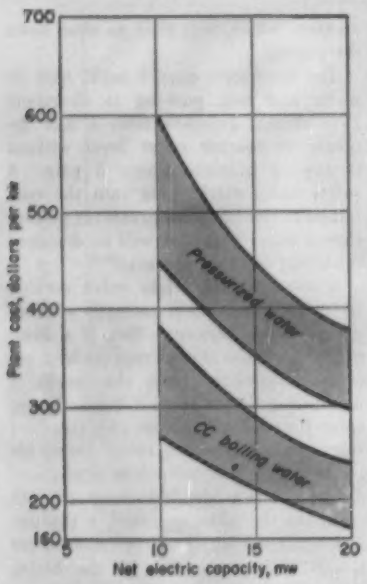
Contaminated water. There will be a small amount of contaminated water leaking from valves and pumps. Leak collectors leading to the sump tank will be installed on all of these components.

Emergency shutdown. If the control rods become stuck, the reactor can be shut down by injecting a boric acid solution into the reactor vessel. A boric acid tank, pressurized by helium, outside the containment shell does this.

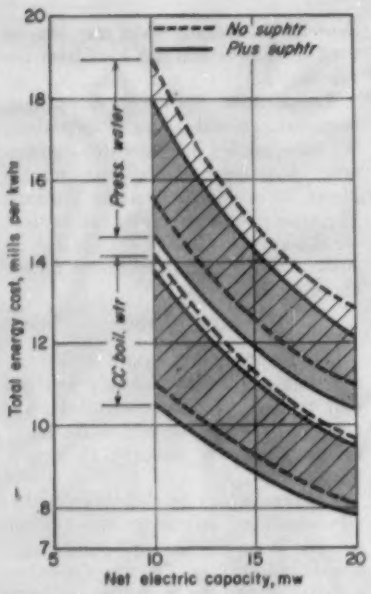
FUEL HANDLING

Fuel elements will be handled under water with simple manual tools and techniques, with some assistance from the overhead monorail crane of about 5-ton capacity. This is how it works: Upon shutdown of the reactor, the reactor vessel and primary loop will be filled with demineralized water from the 50,000-gal storage tank. Then the water-shielding tank surrounding the reactor will be filled with demineralized water to a level slightly below the lead seal. A built-in electric heater to melt the lead seal will be energized, and the cover blocks removed with the monorail crane.

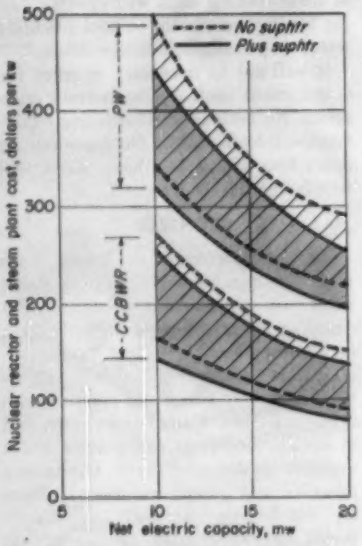
After removing the metal cover plate the water level will be raised to slightly below the floor level. A platform will



5 Total plant-investment cost excludes nuclear-fuel charge. Upper limits are estimates for first two plants, lower limits are expected costs for later plants, no drop in future nuclear fuel cost

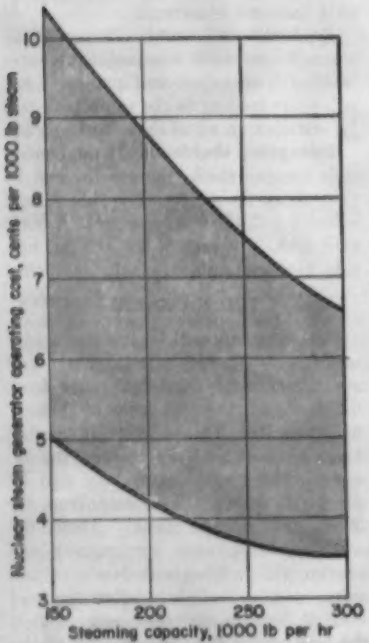


6 Separately fired superheaters show advantages for both pressurized-water and closed-cycle reactors. Based on superheater fuel at 30¢ per million Btu and 80% load factor for the plant

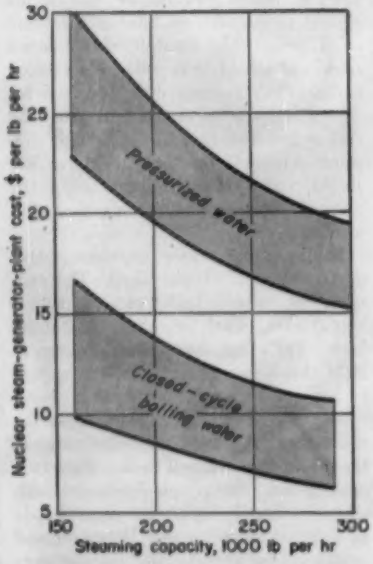


7 Unit cost of closed-cycle boiling reactor shows considerable advantage over pressurized-water reactor. These figures exclude the nuclear-fuel charge, superheater, and turbine plant investment

Nuclear-fuel plants may compete with fossil-fuel plants



8 Labor and maintenance cost per 1000 lb of steam at 630 psig from reactor receiving feedwater at 350 F. To take into account the cost of nuclear fuel loading add 21.5¢ per 1000 lb



9 Nuclear steam-generator plant investment to produce 630-psia saturated steam from 350-F feedwater. The investment for nuclear fuel is not included. Based on 80% plant load factor

be placed across the reactor opening.

Working at this platform, using underwater lights and extension tools, the reactor-vessel cover plate will be removed with the help of the crane. Spent-fuel elements will be removed from the core and placed in fuel storage pockets for a further cooling period. (After cooling for a suitable period, the spent fuel would be placed under water in lead casks for removal.) After fresh fuel has been inserted, the reactor cover, metal cover plate, lead seal, and shielding blocks are replaced.

Meanwhile the containment quench tank, blowdown quench tank, feed tank, and sump tank are emptied. Most of this water, having been cooled for a 6-month period, should have very low radioactivity so it probably could be discharged to the river without danger. An outside storage tank, however, will provide a further six months to a year cooling.

The shielding water is then drained into the containment quench tank providing the refill for this. Bringing the reactor up to pressure and tempera-

ture, perhaps with auxiliary heating, drains the water in the reactor vessel and primary loop into the blowdown quench tank and feed tank to provide their normal fill.

PLANT COSTS

Considerable effort has been made to design some components to do more than one job. Here are some of the units with their primary and secondary purposes:

1. *Blowdown quench tank*—(1) relieve reactor pressure (2) cool reactor blowdown (3) vent trap discharge.

2. *Containment quench tank*—(1) containment pressure relief (2) shielding-water and radioactive cooling.

3. *Containment pressure shell*—(1) accident containment (2) concrete forms.

4. *Concrete*—(1) shielding (2) containment reinforcing.

Reactor comparison. We made detailed cost studies on only the PWR and CCBWR plants. Costs for all plants were computed for three sizes—10, 15 and 20 mw net electrical output, see table p 77. Here are the arrangements of the plants listed in the table:

1. *Modified APPR*—The Army packaged power reactor blown up to required size, but with natural uranium spiked core rather than the original APPR design. Pressurized-water reactor runs at 1200 psig supplying 236-psig steam to turbine. Extensive studies of this design made it logical starting point—many cost quotations obtained for APPR were modified and used in our study.

2. *Pressurized water*—Same as Modified APPR except that reactor pressure is raised to 2000 psig and steam pressure to 630 psig.

3. *Pressurized water, superheated*—Same as (2), above, with a separately fired superheater added to raise steam conditions to 600 psig, 825 F.

4. *AMF closed-cycle boiling-water reactor*—Described in text, supplying 630-psig saturated steam.

5. *AMF closed-cycle boiling-water reactor, superheated*—Same as (4) except that separately fired superheater raises steam to 600 psig, 825 F.

6. *AMF closed-cycle boiling D_2O*—Same as (4) except that heavy water is used in primary loop. Small inventory of fluid and sealed loop make AMF closed cycle ideal application for heavy water, but table shows it is not economically justified at present prices.

7. *AMF closed cycle boiling D_2O, superheated*—Same as (5) except that reactor uses heavy water.

Fig. 3 to 9 show various costs, most given in the table, for the three sizes of plants. Shaded areas, in Fig. 4, 5, 6, 7, 8 and 9, show ranges of costs; upper limits are costs for first or second plant built as listed in table. Lower limits assume that after second plant is built, engineering, development and startup costs for nuclear reactors will be no more than twice present costs for conventional boiler plants. Also, after the second similar plant is built, fabrication and construction costs will be reduced by 10%. Heavy-water plants have not been included on any of the curves.

Fig. 6 assumes that for later plants maintenance costs will be comparable to those of conventional steam plants. No credit is taken for possible future reduction in nuclear-fuel costs. The total energy costs will be different for load factors other than 80% and capital cost rates of 15%, used in figuring these curves.

Fig. 7 shows the costs for the *nuclear steam generator* only, excluding superheater and turbine-electric portions of the plant. By comparison, Fig. 5 shows the total plant costs.

Fig. 4 shows the labor, maintenance and fuel costs on the *nuclear steam generator* only. Labor and maintenance costs within the shaded area cover all types of reactors.

Fig. 8 and 9 show investment and operating costs based on steam output of the reactor rather than electrical output.

Planned 'accident' blows up boiling-water nuclear reactor

► WATER-COOLED AND MODERATED experimental reactor, Borax I, was built in 1953 by Argonne National Laboratory people in the AEC National Reactor Testing Station in Idaho. A two-year series of tests showed that properly designed reactor automatically shuts itself down when allowed to go out of control. Final experiment on July 22, 1954 purposely destroyed the reactor, above.

Reactor stands inside partly buried open tank at center of earth mound. Control-rod housing stands over tank on movable platform. The "accident" was staged by spring-ejection of the central control rod out the bottom of the core. It took only 0.2 sec to push the rod out—in 0.1 sec reactor power rose to over 10,000,000 kw with the rod about 80% out of the core. Melting fuel elements produced terrific flash generation of steam, bursting reactor tank and hurling control mechanism and core high into the air. Most fuel fragments fell within 200 ft of reactor. There was no appreciable radioactive fall-out a few hundred feet from reactor. A few pounds of TNT could produce same explosive effects. The reactor tank, 4 ft in diameter, stood about 13 ft high. Water filled this tank from 3 to 4½ ft above the core when producing steam from fission heat.

European makers of closed-circuit TV gear are fast finding new industrial uses for their equipment. Recent British installation in Windscale plutonium plant permits examining reactor innards on maintenance shutdown. As in U.S.A, call for color is limited

FURNACE-VIEWING SETUP using Marconi equipment. Photo taken during initial experiments at the British Electricity Authority's plant at Little Barford, Hunts

Europe's ITV eyes new industrial jobs

By **LEO WALTER**, *Consulting Engineer, Cheltenham, England*

► A FEW YEARS AGO the TV camera was introduced to boiler houses by American makers of closed-circuit TV, called industrial television or ITV (Sept '49, p 120; Apr '53, p 78). Meanwhile, European makers of similar equipment have not been idle. Several firms developed a small, light-weight camera to view smoke intensity, water level, combustion and mechanical handling operations in the modern power plant. Right now many manufacturers in Britain and at least one each in Germany, Switzerland and France are producing ITV equipment. Table, p 83, outlines design details of some British-made ITV gear, with more on the way.

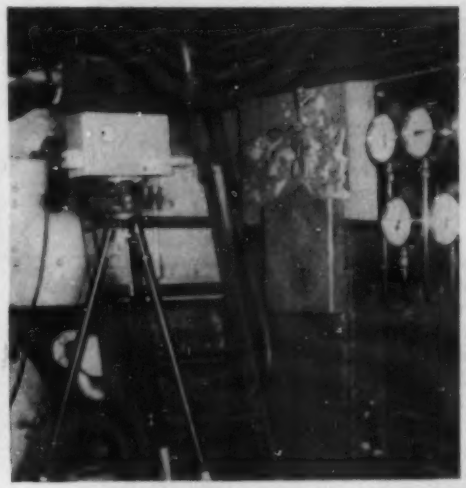
Typical features of present British equipment: Marconi camera has low power consumption, is available for 525 or 625 lines. Emitron equipment has electronic "zoom" control enabling power man to increase to four times the effective picture-scene area without loss of focus. Pye includes facilities for remote control of camera focus plus the standard controls.

In selecting any of this equipment, it is necessary to know the precise working conditions, such as viewing distance, lighting, size and speed of objects, desired image size. One type of camera might require 300 lux (a lux equals one lumen per sq cm or 0.0929 ft-c) at a 1:2 focus opening, while another could be used with but 75 lux if object movement were slow. Image quality varies as a function of working conditions and tube type. We take care in lens selection since there is a definite relation between object width and height, camera distance, image angle and lens characteristics.

Recent announcement stated eight ITV [illegible] were being supplied to Central Electricity Authority, in London, owner and operator of all British power stations. Installation is to be in the new power plant at Willington "A" in Derbyshire, England. Atomic-plant operation and inspection is another fertile application area. ITV will be supplied by the United Kingdom Atomic Energy Authority for use at the Windscale plutonium factory in Sellafield, Cumberland; Marconi will be the supplier. Here the atomic scientists want information on reactor conditions after several years' service. Direct observation is impossible because of radiation, even with the reactor shut down for maintenance. ITV means condition within reactor can now be studied.

Continental ITV equipment follows, in general, the lines of American and British gear. Phillips Electrical Ltd of Eindhoven, Holland, has developed a 4-component system; camera, operating panel (with pulse generator, camera supply, control, monitor), projection units, sound system if needed. One tele-lens and one regular lens make possible closeups and over-all views. Each camera (measuring 8 x 8 x 12 in.) has an electronic view-finder. A 15-meter cable connects camera and supply unit. Control and operating panel houses the pulse generator. Latter develops impulses necessary to synchronize camera and projector. Camera supply-equipment gives all voltages and saw-tooth currents needed by the camera circuits. Monitor panel (14x20x14 in.) includes a 9-in. cathode-ray tube on which the camera picture is seen. Projection unit flashes a picture on a 3x4-ft screen for audience viewing. Optional sound equipment may be built into control and operating panel. Pye Ltd, of Cambridge, England, has developed a high-temperature-resistant television camera.

German power plant, Bewag AG Power Station in West Berlin, has installed ITV. Here, supervision and control of boiler house and power plant plus electrical load distribution is handled from a central control room. Present plant has two conventional water-



REMOTE METERING scheme best handled by camera fastened permanently overhead

GERMAN-MADE EQUIPMENT, above, is manufactured by Fernseh GmbH in cooperation with Siemens & Halske A G, Berlin. The unit will operate with a 200-lux intensity

Industrial television equipment manufactured in Britain

Manufacturer, tube type	Camera	Control system	Scanning standards	Power consumption (watts)	Picture-display unit
Marconi's Wireless Telegraph Co Ltd Vidicon system	One standard 16-mm film-type lens. Additional lenses can be supplied. 5¼ x 4 x 11⅜ in. 4½ lb	Remote optical focus control can be fitted as an optional extra. 7⅞ x 11 x 8¼ in. 18 lb	525 or 625 lines; noninterlaced	100 without picture-display unit)	Any 525 or 625 line receiver. Special monitor can be provided if required
Emitron Television Ltd, London Emitron 5907	One standard 35-mm film-type lens. Additional lenses can be supplied. 6½ x 10¾ x 14 in. 22 lb	Electronic "zoom" control with automatic focus. Remote control of camera lens filter. 17 x 26 x 8¼ in. 83 lb	405, 525 or 625 lines; interlaced	500 (including picture-display unit)	Any suitable receiver
Pye, Ltd, Cambridge Staticon system	f 1.9, 1-in. focal-length lens fitted. Additional lenses can be supplied. 5¼ x 5¼ x 10 in. 8½ lb	Gives full electrical control of camera and also remote optical focus control. 14 x 6⅛ x 16⅜ in. 30 lb	405, 525 or 625 lines; interlaced	150 (without picture-display unit)	Any suitable TV receiver. Special monitors can be provided if required

tube boilers feeding two 50-mw topping turbines. Firing equipment also includes four Benson boilers. Closed-circuit TV was adopted to indicate water level in boilers.

Photo, *above right*, shows equipment made by Fernseh GmbH in cooperation with Siemens & Halske AG, Berlin. The basic elements may be assembled in various combinations depending on operating conditions, panel design. Switches for contrast and light intensity are provided. Several cameras may be used, each capable of being switched over to control-room monitor if needed. Field tests indicate 200 lux are sufficient for this camera to produce a clear image of boiler-glass level. However, most installations use about 500 lux. With suitable filters, same camera can be adapted for furnace viewing.

Above system adopts the European standard of 625 lines and 50 half-images per second. Camera uses compressed air to guard against dust infiltration. In Berlin's Bewag installation a selector switch at the power unit permits switching to several cameras in any sequence. The control operator can receive at will, on a single receiver, images of combustion, smoke from stacks and water level.

When selecting number of viewing lines for the Siemens & Halske system, it was felt water-level transmission could be handled with a comparatively low number. But observing furnace flame conditions calls for the European standard of 625 lines producing 50 half images per second.

European ITV makers are well on the way to providing power men with equipment of high quality at reasonable cost. American manufacturers now have color and stereo TV available. But in U.S.A., as in Europe, there is limited industrial-power need for these refinements at the present time.

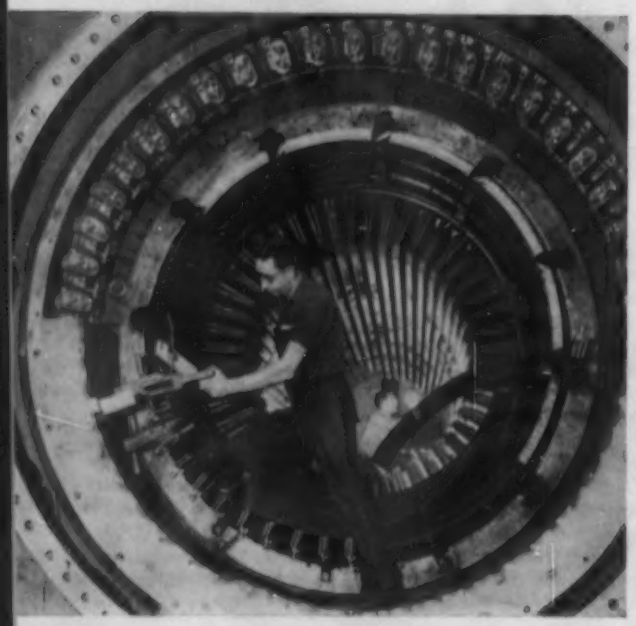
First canned motor-pump installed in utility generating station

► Virginia Electric Power Co has placed in service at its Possum Point Generating Station the first canned motor-pump ever used to circulate boiler feedwater in a closed-loop system. This is the first industrial application of the canned motor-pump originally developed by Westinghouse in connection with an atomic-submarine engine contract.

Canned motor-pump, now built by the Westinghouse Atomic Equipment Dept, is a hermetically sealed unit that provides a means for circulating a liquid coolant or other fluids in high-temperature high-pressure closed-loop systems with zero leakage. All parts in contact with circulated fluid are of corrosion-resistant alloys. There are no external shaft seals: Suction and discharge nozzles are welded into pipe, forming the closed-loop system. Fluid circulates through pump-drive motor; through the bearings and the magnetic gap. Circulating fluid serves as bearing lubricant.

Windings are protected from hot coolant liquid by lining stator bore with a cylinder of thin nickel-alloy sheet, welded leak-tight in place. Rotor is canned in a similar manner. Unit in Possum Point Station circulates 4700 gpm of 605-F water at 1725 psi continuously. It is driven at a speed of 1800 rpm by a 150-hp 440-v 3-phase 60-cycle motor.

The canned motor-pump offers other advantages aside from zero-leakage features—of signal importance in a closed-loop boiler feedwater system. First of all, being small and light, it is extremely simple to install: Lower in place and connect two services—cooling-water lines and 440-v ac power. Secondly, the instrumentation is minimal. Here a cooling-water flow indicator and a pumpbearing thermocouple are connected to light and buzzer circuits. Finally, being hermetically sealed, it can operate without an injection water bleed. With no external shaft seals, maintenance is simplified.



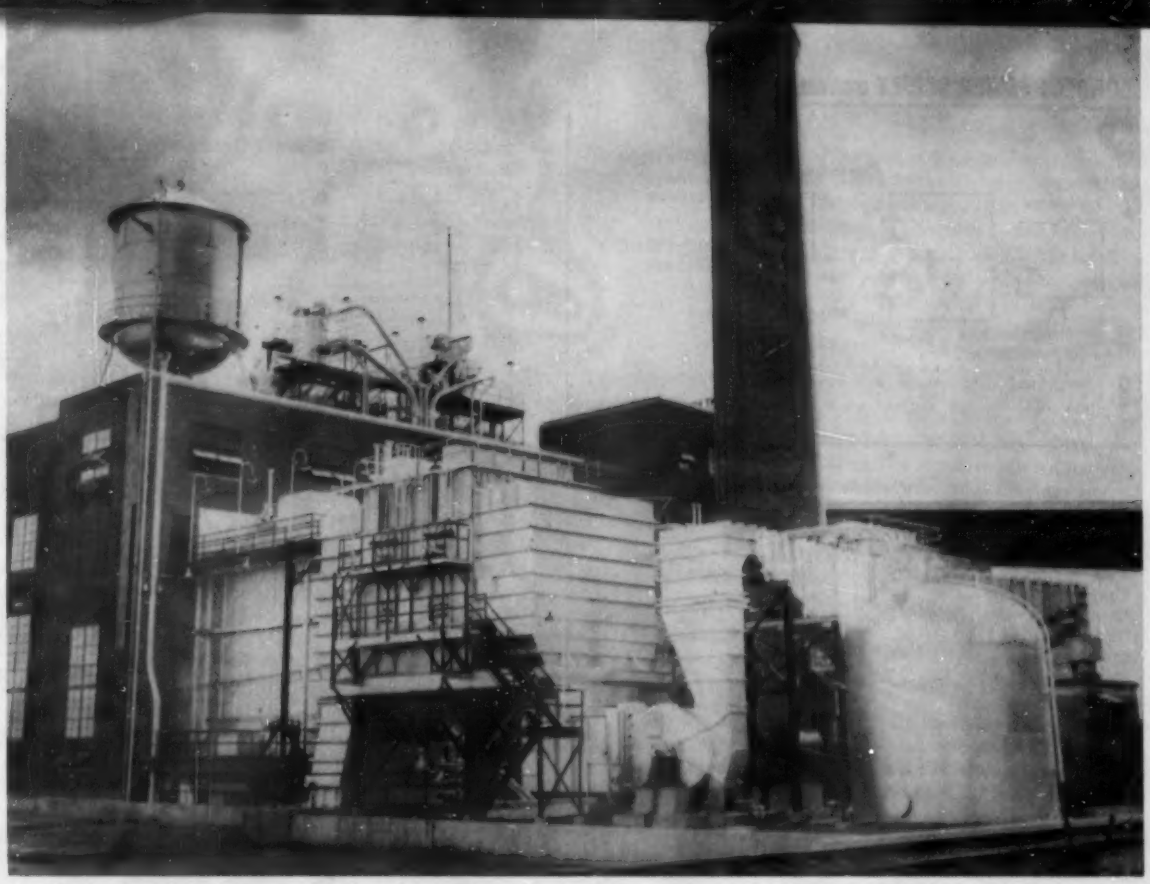
Liquid-cooled generator almost ready

► First large generator with liquid-cooled stator is being built by General Electric and will be installed in the Eastlake Power Plant of the Cleveland Electric Illuminating Co. The new unit, now nearing completion, carries a full-load nating of 260,000 kva.

New method of circulating a liquid coolant through hollow windings in the generator stator is a major step in the development of large capacity generators, according to GE engineers. Liquid-cooled design will make possible a significant increase in capability without increasing physical dimensions. Higher capacity results from more efficient removal of heat produced in electrical generation.

Most common method of generator cooling requires the circulation of hydrogen gas through passages in the magnetic portions of both rotor and stator. This latter method of cooling is still highly efficient and is being used for units rated up to about 220,000 kva capability at 3600 rpm.

Eastlake unit is one of the largest 3600-rpm steam turbine-generators in the world. This power maker will be capable of supplying the household electrical needs of 700,000 people. Three conventional hydrogen-cooled turbine-generators, each rated 125,000 kva, are already operating at Eastlake.



1 Typical power-plant electrostatic-precipitator installation for flyash recovery. Next to the power-generator building are the integral furnace boiler, the precipitator and breechings with condensate storage tank standing in the foreground

Correct power supply: key to efficient electrostatic-precipitator flyash collection

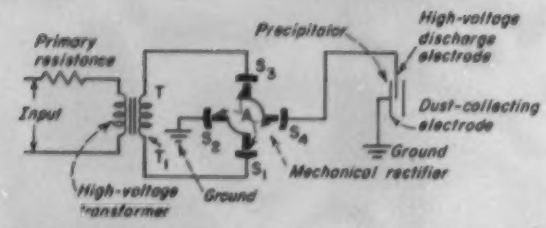
C E Beaver, Vice-President, Research-Cottrell, Inc, points up . . .
Requirements of power-rectifier equipment for electrostatic precipitators.
Operation of mechanical and electron-tube types, trends in selection

► FOR EFFICIENT flyash collection, proper balance between power supply and load must be designed into the precipitator and maintained by operating the unit correctly. Basic elements of an electrostatic precipitator's power supply are switchboard, transformer and rectifier. Because the rectifier is the heart of the system, it is through voltage-rectifying problems that we may best understand precipitator power supply and the need for high dust-collection efficiency—over 95% in most modern precipitator installations.

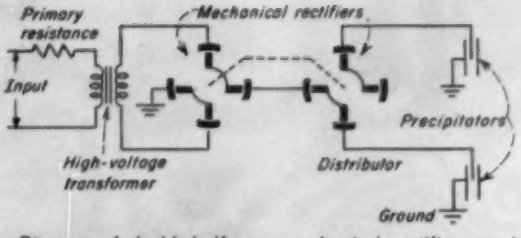
Electrostatic precipitator. This equipment has two sets of electrodes: the discharge and the collecting. The discharge usually consists of wires or small rods, insulated from ground and supported between the collecting electrodes, made of steel plates of large-surface area, Fig. 6. These plates are permanently grounded, while the discharge electrodes are negatively charged at 15,000 to 100,000 volts or more.

The high potential between the discharge electrodes and the plates produces a strong electrical field between them. This field negatively charges the solid particles in the gas stream as it passes between the plates. These charged particles are attracted to the positively charged plates (collecting electrodes) where the particles give up their charge and are removed by rapping or vibration to hoppers below the electrodes.

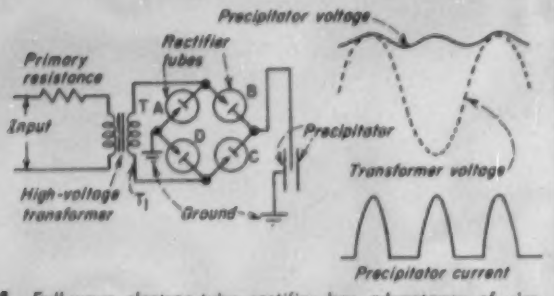
Voltage and current. Electrostatic-precipitator performance is improved by using pulsating instead of direct voltage. Long experience has proven this fact so that unfiltered voltage is



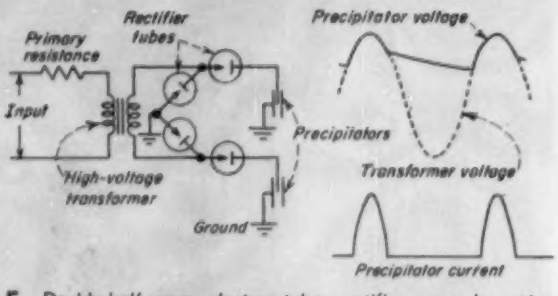
2 Simplified diagram of full-wave mechanical rectifier. It has same voltage, current wave forms as electron-tube type



3 Diagram of double-half-wave mechanical rectifier permits more precipitator sections with given number of rectifiers



4 Full-wave electron-tube rectifier has advantages of simple construction and operation, does not emit toxic gases



5 Double-half-wave electron-tube rectifiers are becoming highly popular for electrostatic-precipitator power service

dictated by corona and current needs of the precipitator. In the past these requirements were determined empirically from previous successful installations. However, recent studies of corona characteristics have placed precipitator electrical requirements on a sound scientific basis.

General requirements for precipitator-rectifier equipment are: (1) adequate voltage and current capacity (2) high reliability (3) operation possible with heavy sparking on the discharge electrodes (4) conservative rating for long life and operation under ambient temperatures, up to 50 or 60 C. Operating conditions are quite severe because some sparking generally is desirable in most precipitators.

It is advantageous to remove as many dust particles as possible from the gas. The operating efficiency of any installation depends on conditions peculiar to it. However, a reasonably accurate expression for dust-collection efficiency may be derived from fundamental principles based on the properties of turbulent gas flow and electric forces acting on the particles. The electric forces cause the particles to drift toward the collecting electrodes. Velocity of this drift is directly proportioned to the particle's radius so large ones collect faster than small ones. But there is no lower limit to particle sizes that can be collected by electrostatic precipitators.

Rectifier equipment. Metallic, synchronous-mechanical and electron-tube rectifiers are used to power electrostatic precipitators. Metallic types are installed extensively in Europe, and the economics of this rectifier, compared to other types, is now such that it is favorably considered for many plants in this country. Which type of rectifier to use depends on several factors. Most of these concern economy.

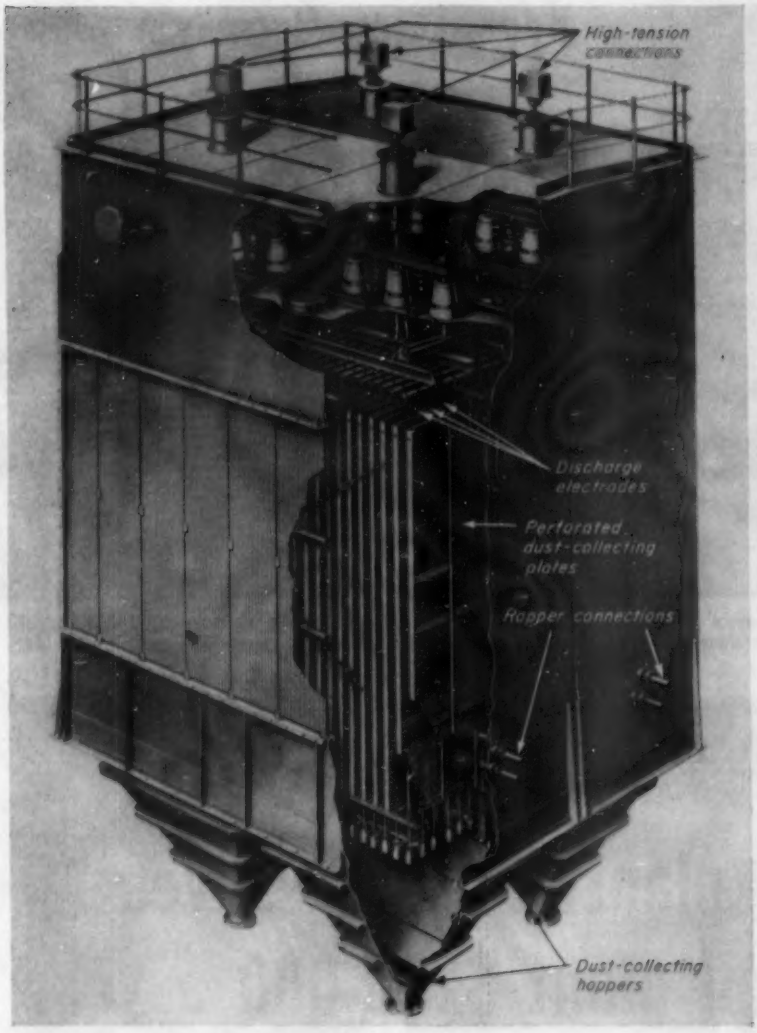
For many years mechanical rectifiers were used exclusively on precipitators in the U.S. There are two types: full-wave, Fig. 2, and half-wave, Fig. 3. Both operate on the same principle and have many like features. In its simplest form a mechanical rectifier has four arms, *A*, Fig. 2, attached to a shaft driven by a 4-pole synchronous-speed motor. Each arm has an arc shoe *S*. The arms are grouped in pairs as in Fig. 2, where they connect arc shoe S_1 to S_2 and S_3 to S_4.

When transformer terminal *T* is minus, a high potential is applied from the precipitator's discharge electrode to the plate and ground to the other half of the rectifier and transformer terminal T_1. On reverse transformer polarity, the rectifier arms have rotated to where they connect arc shoes S_2 to S_3 and S_4 to S_1. This connects transformer terminal T_1 to the discharge electrode so a high voltage is again applied from this electrode to the collecting plate as when transformer terminal *T* was minus.

In this way the high potential is always applied from electrode to plate even though the power source is alternating current. Since the rectifier is driven by a synchronous motor operated from the same power lines as the high-voltage transformer, the speed of the rectifier arms are locked in step with the frequency of the transformer output. Mechanical-rectifier voltage and current wave forms are the same as for vacuum-tube rectifiers, shown to the right, Fig. 4 and 5.

Protective devices. Mechanical-rectifier systems usually include devices to prevent high-frequency voltages from going back into the power lines where they might interfere with other equipment operation. A static and surge reducer consisting of three condensers and three resistors connects from each power line to ground. To prevent radio interference, coils are sometimes mounted at the rectifier's arc shoes. These coils eliminate radio interference in the commercial broadcast band and help to reduce short-wave interference. Resistance rods are connected at each arc shoe of the rectifier to smooth out peak voltages and high-frequency oscillations that may occur in the circuit.

Adjustments. Gap clearance between rotating arms and arc shoes in mechanical rectifiers should not exceed ⅛ in.



6 This four-section flyash precipitator has perforated collecting plates and a magnetic-impulse rapping system on the high-tension and collector electrodes

Larger clearances increase power and voltage losses in the rectifier and reduce precipitator efficiency. Accurately phase mechanical rectifiers with the alternating-voltage waves so rectification occurs at their peaks. Out-of-phase rectifier adjustments may be detected by appearance of spark pattern at the arc shoes, by excessive rectifier current and loss of precipitator efficiency. Phasing may be corrected by observing the spark pattern or by oscilloscope study of primary voltage of the high-voltage transformer.

Vacuum-tube rectifiers have gained favor in precipitator power-supply systems during the last ten years. Average life of a vacuum tube in precipitator-rectifier service is from 10,000 to 15,000 hr, but a life of 30,000 hr is not uncommon.

For precipitator applications these rectifiers, like mechanical rectifiers, are of two general designs, full-wave, Fig. 4, and half-wave, Fig. 5. In their operation a hot cathode emits electrons to an anode when the anode potential is positive. When the voltage reverses, current does not flow through the tube.

Operation. In Fig. 4 when the transformer terminal T is minus, a high-potential is applied through tubes B to the electrode, plate and ground, tube D to transformer terminal T_1. On reverse polarity the transformer's terminal T_1 connects through tube C to the precipitator electrode to hold it always at the same polarity. For this type rectifier precipitator, voltage and current curves are shown at the right in Fig. 4.

Vacuum-tube rectifiers have the advantage of simple construction and operation. They do not emit toxic gases or cause radio noises. They operate quietly and require only such maintenance as an occasional dusting off and replacement of a worn-out tube. Periodic checking of vacuum tubes is not recommended because the delicate filaments inside the tube may be damaged.

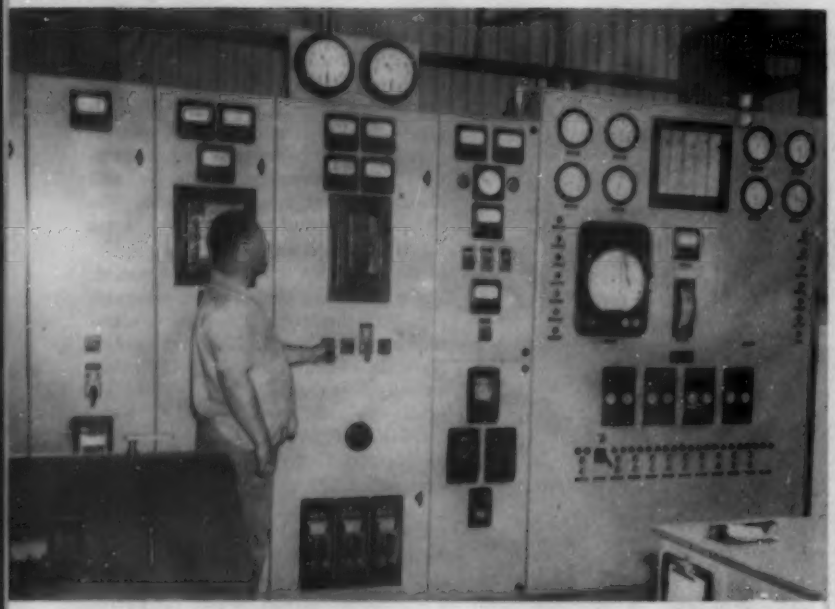
For power supply to electrostatic precipitators the trend is toward vacuum-tube rectifiers because they are easy to maintain and low in cost. In 1949, they were used on only about 25% of all precipator rectifiers in the U.S. Now, more than 80% of all rectifiers supplied by Research-Cottrell are of the vacuum-tube design.

Filament-voltage adjustment in these tubes is a critical factor in their life. As a rough guide, a 5% increase in this voltage will halve filament life, whereas a 5% reduction will double it. Therefore, filament voltage should be no higher than needed for satisfactory omission. General practice is to use a filament voltage 5 to 10% below rated value, that is 18 or 19 v instead of 20. Filament voltage stabilizers are now used more frequently, particularly where line voltage varies more than a few percent.

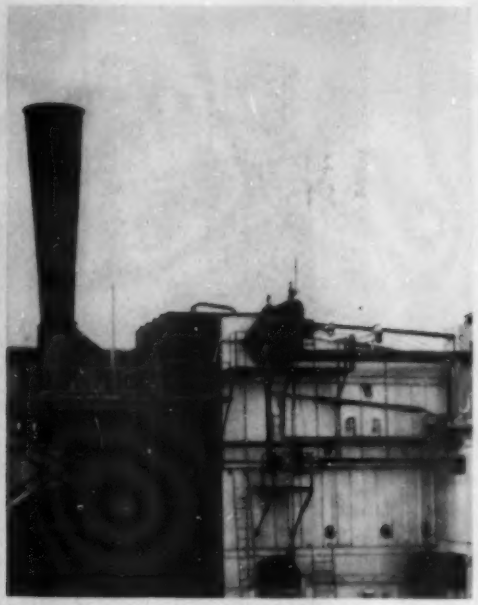
Current-limiting devices. Because of sparking conditions in the precipitator load, their rectifiers require some form of impedance or other device to prevent excessive currents and power-line surges when the precipitator sparks over. A resistor in the transformer primary circuit, Fig. 2 to 5, is satisfactory for most precipitator applications. Also, a certain amount of secondary resistance is generally used, mainly to suppress possible oscillations that may occur in this circuit when the precipitator sparks. An inductance or choke coil in the primary circuit serves equally well as a resistor for a current limiter and has a slight theoretical advantage of higher electrical efficiency.

Several other current-limiting devices have been tried or suggested. These include circuit networks, current-limiting diodes, and other electronic circuits. These methods have theoretical advantages, particularly in electrical efficiency, but practically they are more expensive than the simple resistor.

Since World War II, research on electrical precipitation has greatly increased available knowledge of electrical characteristics and power requirements for precipitators. Out of this work has come an automatic voltage-control system to hold precipitator voltage at the highest possible level.



CONTROLS AND SWITCHGEAR for this industrial power plant are designed for one-man operation. Boiler panel, *right*, can hold another recorder, for future expansion



OUTDOOR BOILER enclosed in watertight casing. I-d fan and stack are one unit

Power plant will pay out in 2½ years:

'Big plant' thinking saves small plant $200,000 a year

By **J SCHNEIDER**, *Plant Engineer* and **H BRETTMAN**, *General Manager, A&P Corrugated Box Corp* and **S RUDGINSKY**, *Director of Engineering, Utility Engineers, Inc*

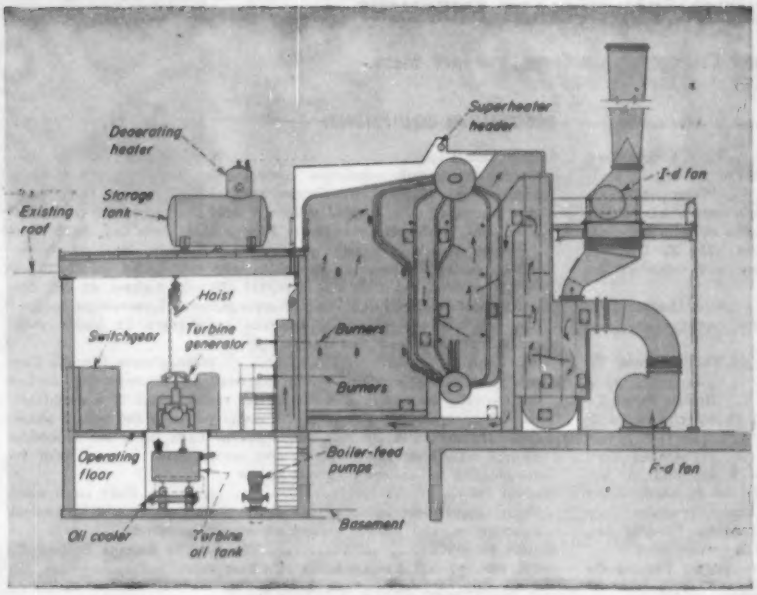
► EXPANDING PROCESS FACILITIES almost always means more steam, more electrical power. And, more often than not, in small and medium-sized plants the answer is: Buy power from the local utility. But when process-steam and electrical-power needs strike an ideal balance—electricity being generated entirely as a byproduct of process steam—smart management can come up with substantial operating savings. In brief, that's what happened when A&P Corrugated Box Corp called in Utility Engineers, Inc to make power studies for their new box-board mill in Lawrence, Mass.

Survey results. Estimates showed that steam requirements for the mill and associated property for paper making, water heating and space heating were 82,000 lb per hr at maximum process load. Electrical power needs, at the same load, were 2700 kw.

The new plant site, former Washington Mills property of the American Woolen Co, included a boiler house with five 10,000-lb-per-hr boilers—50 years old. To keep its initial investment to a minimum, A&P planned to add one 50,000-lb-per-hr boiler and buy electricity.

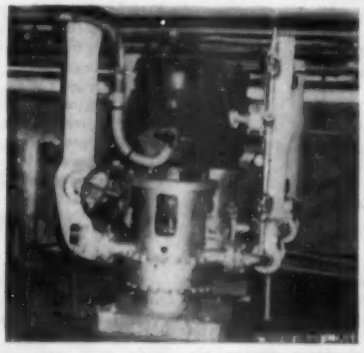
But detailed load studies soon showed that minimum investment wasn't the right road to minimum over-all cost. Specifically, a noncondensing steam turbine, operating at 600-psig 750-F throttle conditions and 50-psig back-pressure, would result in a steam-electricity balance at normal mill capacity—150 tons of box board per day—slicing operating costs by more than $200,000 yearly. Based on a $500,000 estimated investment, pay-out time would be about 2½ years—a piece of simple but highly attractive arithmetic. And A&P gave its OK to the proposal.

Design features. To build the power facilities at minimum cost—and still realize low operating costs—engineers based their design on this thinking: (1) Single boiler, single turbine. Reliability of a single-boiler single-turbine power plant is as good if not better than that of the single paper machine installed. (2) All but essen-



SECTIONAL VIEW of plant shows up neat, compact layout. Units in basement are run from the operating floor. Turbine room supplies cover fo b iler firing aisle

BOILER WALKWAYS are accessible from turbine-room roof, permit valve operation



BOILER-FEED PUMPS are vertical type, to save space. Pumps are in basement

sential equipment to be deferred until the mill operated successfully. This decision was needed to keep costs within a tight budget. (3) Semioutdoor construction—to minimize building cost. (4) One-man operation. This setup cuts operating costs but calls for all controls, switchgear and paper-mill feeder breakers to be centrally located in the power plant. (5) Minimum-size building. Keeping building size relatively small inconvenienced construction. But extra cost of inconvenience was more than offset by lower building costs. (6) Paper-mill-machinery 2300-volt motor starters to be in powerhouse to protect them from hose streams and moisture.

Layout. Locating the boiler outdoors, with only the firing aisle enclosed by the turbine room, cut initial costs. Draft fans are also outdoors, at rear of boiler. Deaerating heater is on the turbine-room roof and fuel-oil pumping-heating units are mounted on the oil tank, in a covered shed next to the powerhouse. Pumps, chemical feed and reducing-desuperheating equipment are in the basement. But instruments for these units are at the operating floor level. So operator makes a trip to the basement only once a shift, for inspection and oiling.

By limiting main steam conditions to 600 psig, 750 F A&P was able to use standard weight A106 Grade B seamless-steel pipe for high-pressure steam and boiler-feed piping instead of expensive alloy-steel piping. Paper-machine dryers set 50-psig turbine backpressure. These units have a 50-psig maximum working pressure.

Boiler is 2-drum type with pendant superheater, weather-tight steel casing and a tubular air heater, yielding an 87% guaranteed boiler efficiency. A&P will be able to install a spreader stoker should future conditions warrant burning coal.

Makeup water is Lawrence city water—coagulated and filtered Merrimac River water. Injecting caustic and sulfite at the boiler-feed suction controls pH and scavenges oxygen. Phosphate feed to boiler drum controls scale. And a continuous blowdown system keeps dissolved solids in the boiler water to recommended levels.

By sizing the deaerating heater to handle only makeup water—and not condensate returns—A&P was able to keep the unit relatively small. Condensate goes directly to the deaerator's storage tank. This setup is practical only because the returns are under pressure at all times—with no chance to absorb oxygen. An auxiliary line admits condensate to the deaerating section during startups, when condensate is saturated with oxygen.

Boiler-feed pumps are vertical type with bronze trim. Vertical pumps were picked for the job—although they cost more—to avoid increasing the building size. Using horizontal pumps would have meant a bigger turbine room just to accommodate the boiler feed pumps. Hatches in the operating floor allow pumps to be withdrawn for maintenance.

Two-element feedwater regulator on boiler front is equipped with bypasses. Location allows operator to see boiler-drum gage glass while turning bypass.

Positioning-type, pneumatic combustion controls are designed for one-man operation. Initial control system is equipped with only essential instruments. A&P engineers can install additional instruments at a later date—as investment dollars become available.

Turbine-generator also came in for its share of cost cutting. Generator rating is 3000 kw at 0.8 pf. Turbine rating is only 2500 kw, but it has enough overload capacity to develop full generator rating. Machine foundation is isolated and supported by six caissons extending to solid ground 36 feet below grade. Closed generator air-cooling system uses river water for cooling. Operators can dismantle the unit when necessary, at the generator end—a space normally used as operating area. *(More on next page)*

PRINCIPAL POWER-PLANT EQUIPMENT

A&P Corrugated Box Corp, Lawrence, Mass.

STEAM-PRODUCTION EQUIPMENT:

Steam generator ..... Riley Stoker Corp
Outdoor, 90,000 lb per hr continuous, 650 psig, 750 F vertical, bent-tube, 2 drum. Boiler heating surface: 7800 sq ft. Water-cooled furnace-walls' heating surface: 1570 sq ft. Superheater: convection, 460 sq ft heating surface in high-temp section, 1040 sq ft in low-temp section. Furnace volume: 3950 cu ft. Feedwater: 280 F. Oil fired with provision for future coal stoker. Erection and insulation by manufacturer

Air heater ..... Riley Stoker Corp
Two-pass tubular, 11,000 sq ft heating surface, arranged to give maximum gas outlet temp of 360 F

Oil burners, 4 ..... The Engineer Co
Steam-atomizing gun type

Forced-draft fan ..... Buffalo Forge Co
Variable inlet vanes, constant speed 1175 rpm, 28,000 cfm at 80 F and 10.2 in. wg, motor drive

Induced-draft-fan stack ..... Prat-Daniel Corp
Inlet louver damper control, 48,000 cfm at 380 F and 7.71 in. wg, constant speed, 1180 rpm. Over-all stack height 30 ft, motor drive

Soot blowers, 5 ..... Diamond Power Specialty Corp
Fixed position, manually operated, rotating elements, 700-psig sat. steam. One high-temp, three medium-temp, one low-temp units

Fuel-oil pumps, 2 ..... DeLaval Steam Turbine Co
Motor drive, rotary screw, 14 gpm, 103-psi tdh

Fuel-oil heaters, 2 ..... Kewanee-Ross Corp
Multipass, 50 psig steam

POWER-GENERATING EQUIPMENT:

Turbine-generator ..... Westinghouse Electric Corp
Turbine: 2500 kw, 3600 rpm noncondensing. Throttle steam 600 psig, 750 F. Exhaust 50 psig. Generator: 3750 kva, 0.8 pf, 3600 rpm, 2400 volts, 3-phase, 60 cps, wye connected

FEEDWATER EQUIPMENT:

Boiler-feed pumps, 2 ..... Ingersoll-Rand Co
Vertical, centrifugal, 8 stage, constant-speed 3250-rpm motor drive, 242 gpm, 1780 ft tdh

Makeup water pumps, 2 ..... Allis-Chalmers Manufacturing Co
Horizontal, centrifugal, constant-speed 1760-rpm motor drive, 50 gpm, 120 ft tdh

Chemical-feed system ..... Milton Roy Co
Sulfite solution to boiler feed-pump suction, caustic and phosphate solution to boiler drum. Two simplex pumps, and two 100-gal tanks

Deaerating heater ..... Worthington Corp
20,000 lb per hr, vertical heater, horizontal storage, steam-jet type with internal direct-contact vent condenser, 10-minute storage of heated and deaerated water at 100,000 lb per hr

ELECTRICAL EQUIPMENT:

Indoor substation ..... Westinghouse Electric Corp
Double-ended, unit substation consisting of high-voltage switchgear section, two 1000-kva transformer sections, and low-voltage switchgear secton, all close coupled to form a dead front metalclad continuous structure. High-voltage section: 5-kv, indoor, metalclad, light duty, draw-out switchgear; one generator-exciter unit, two transformer units, two utility incoming-line units, and two feeder units. Transformer section: two 1000 kva, 2400/277-480 volt, 3-phase, 60 cps, dry-type transformers in double-ended arrangement. Low-voltage section: 600 volt, indoor, metalclad, draw-out switchgear; 12 feeder units, one bus-tie unit, and two transformer units

Motor control ..... Westinghouse Electric Corp
All power-house auxiliary motor starters and disconnecting devices are centrally located in a motor-control center which is a dead-front, metalclad, continuous structure. All motor power is 480 volt, 3 phase, all motor control is 110 volt, single phase. Each motor has individual control transformer in its respective compartment integral with its combination full-voltage magnetic starter

Neutral cubicle ..... Field constructed
Contains generator lightning and surge protection, neutral instrument transformers, and neutral ground disconnecting switch

Station battery ..... The Electric Storage Battery Co
120 volt, 60 cell, 80-amp hours at 8-hour rate

INSTRUMENTS AND CONTROL SYSTEMS:

Combustion-control system ..... Hagan Corp
Fuel-oil press control ..... Hagan Corp
Two-element feedwater control ..... Hagan Corp
Desuperheater stations (2) ..... Copes-Vulcan Div, Continental
Pressure-reducing valve ..... Foundry & Machine Co
Level indicators ..... Yarnall-Waring Co
Boiler meter ..... Hagan Corp
Turbine meter ..... Hagan Corp
Recording-temperature controller ..... Taylor Instrument Cos
Recording-pressure controller ..... Taylor Instrument Cos
Pressure gages ..... Manning, Maxwell & Moore, Inc
Boiler-drum-level gage glass ..... Ellison Draft Gage Co
Liquid-level controls ..... Minneapolis-Honeywell Regulator Co
Indicating thermometers ..... Taylor Instrument Cos

MISCELLANEOUS EQUIPMENT:

Air compressors, 2 ..... Quincy Compressor Co
Vertical, 2-stage, air-cooled, tank-mounted, reciprocating, 63.5 cfm, 100 psig, 800 rpm, 200-gal receiver

Motors ..... Allis-Chalmers Mfg Co, Howell Electric Motors Co

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Electrical. Pegging the generating voltage at 2300 v was found to be the most economical. All motors over 100 hp in the paper mill operate at this voltage. Smaller motors use 440 volts. The electrical system is ungrounded and the generator is equipped with differential protection.

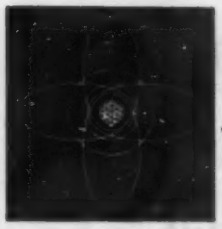
Outside power source feeds into a substation consisting of two banks of three 13,800/2300-volt transformers. Capacity of each bank is 2000 kva.

Switchgear is metalclad and includes: (1) generator panels (2) panels for incoming utility connections (3) 2300- and 440-volt feeders to the paper mill (4) two 1000-kva 2300/440-volt metalclad dry-type transformers. A 440-v metalclad motor-control center serves power-plant motors.

Powerhouse wiring, including generator leads, incoming power and primary and secondary distribution, runs in trays rather than rigid steel conduits —another item that helps keep costs down. And the trays need less than one-quarter of the space occupied by rigid steel conduit.

Freezing protection, as far north as Lawrence, Mass., is an item A&P could not afford to overlook. They had to protect a substantial part of the outdoor piping and instrument air lines from freezing. Thermostatically controlled electrical-heating cable, actuated by outside air temperature, proved a practical answer.

Complete plant cost was $480,000—just below the original $500,000 estimate. After a year of operation, A&P has bettered predicted efficiency, and reliability of the unit-type design has lived up to our expectations. During this period A&P was faced with only one forced outage. Melting snow around the hot i-d fan dripped into the f-d fan inlet louvers and later froze up. Result: Louvers failed to respond to control signals. Installing gutters to dispose of the water provided a simple solution to the problem.



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Homogeneous-type reactor, to generate about 150,000 kw, will be in service by 1962 according to plans of the Pennsylvania Power & Light Co. They have engaged Westinghouse Electric Corp as codeveloper to design and build the plant for them. The new station is expected to be commercially competitive with plants using conventional fuels. The project will be privately financed.

Closed-cycle boiling-water reactor to produce 22,000 kw has been proposed by the Rural Cooperative Power Assn of Elk River, Minn. They expect to cut their production costs from 9.25 to 6.4 mills per kwhr. Proposal asks loan from AEC for reactor construction and loan from REA for turbine-electric equipment. American Machine & Foundry will build reactor, see pp 75-81 this issue.

High-energy atom smashing produces particles called mesons, which appear in bewildering number and variety. Impact energy seems to create them. These have been uncovered by the 3-billion-volt cosmotron at Brookhaven (cost $10 million) and 6-billion-volt bevatron at Berkeley. New Brookhaven 25-billion-volt accelerator with half-mile particle-orbit diameter will cost $20 million and is expected to reveal more information on meson behavior and structure of the atom.

Taming the hydrogen bomb, so controlled fusion as well as fission generates usable power, seems favorite topic of rumor discussions. More definite information appears to be in the offing—Hans Thirring, Director, Institute of Theoretical Physics, Vienna, will talk on *Non-weapons Potentials of Thermonuclear Energy* at the National Industrial Conference Board's 4th annual conference on "Atomic Energy in Industry," Oct 26 to 28 at Waldorf-Astoria Hotel, New York, N.Y.

First atomic trade fair will be sponsored by Atomic Industrial Forum in Washington, D.C., Sept 27-29 at the Sheraton-Park Hotel. About 70 groups will be exhibiting. For tickets write the AIF at 260 Madison Ave, New York 16, N.Y.

"World Development of Atomic Energy," sold for $5 by the AIF, covers activities in 32 nations. There are 42 known nuclear reactors in the world today. The survey reports on 17 nations having uranium deposits and four having thorium. The report includes copies of agreements for cooperation between U.S. and other nations. Also listed are the titles of papers being published in the proceedings of the UN Conference on Peaceful Uses of Atomic Energy.

Standards for protection against radiation have been approved by the AEC, subject to revision after appearing in the Federal Register. The regulation gives maximum limits on exposures to external radiation, concentrations of radioactive material, and maximum levels of radiation in adjacent areas not controlled by licensee. These levels provide a substantial margin of safety for personnel and the public.

Regulation for licensing operaters of atomic production and utilization facilities have also been approved by the AEC subject to later revision. Licenses will be needed only by persons responsible for making decisions on control manipulations. Unlicensed students or trainees can handle controls under personal supervision of a licensed operator. Applicants must pass medical check and demonstrate general knowledge of operation of reactor facility. Operator's license will expire two years from date of issuance; if not actively operating during two years he has to pass another examination to get renewal.

Four types of pulverizers feed coal to our modern steam generators

Does pulverizer output depend on coal feed or air flow? Can you avoid fires with unit shut down? How does your pulverizer work? Here are answers, with operating info

By D C SWIFT, *Ebasco Services Incorporated*

► ALONG WITH GAS, oil and solid fuel (discussed last month), pulverized coal is a major fuel for today's boilers. There are four general types of pulverizers—tube, bowl, ball and impact.

All pulverizers act to prepare and deliver fuel to the furnace with enough air to suspend the dust and burn the volatile matter. Here's how each of the four systems works:

Tube mill grinds fuel by hardened-steel balls, cascading in a slowly turning tube or barrel with erosion-resistant liner plates. Coal feeds into one or both ends of the mill through open trunnions. Hot air dries the coal and carries out the finely ground particles.

Coal-air mixture leaves through another duct in the trunnions. Then a separator returns the coarser particles for further grinding. Raw coal is supplied as necessary, so there is a constant layer of ground coal above the ball level.

Output depends on amount and velocity of air through the mill. This holds up to the point of maximum grinding capacity. If coal is excessively wet or is overfed, mill may become so loaded that balls slide or fall in large groups, rather than in a continuous cascade. Then pulverizing capacity falls off, and you get an uneven reduced-power consumption. In addition, the noise from the mill becomes uneven.

Meters to indicate power input to the drive motors help you determine mill conditions. The units are usually carried under a slight suction by manual or automatic control. Preheated air balances the air and coal removed by the exhauster fan.

Mill suction, differential and level are usually indicated at the operator's control position. Level is shown by two or more pipes set at different levels. They are more or less covered by the layer of fine coal on top of the balls. If pipe end is uncovered, suction shown is essentially mill suction. If pipe is covered with coal, a small vent hole outside the mill lets air enter faster than it can be carried away. As a result, pipe suction falls to close to atmosphere. This variation operates the feeder controls and gives the operator an indication of level by gage readings. To get accurate level indication, vents must be properly sized and the pipes must be kept open.

If mills are running too close to capacity, they will be swept free of finer particles. This reduces grinding capacity and makes the level indicators act as though coal level were lower than it actually is. Hence, there is a tendency toward overloading. Correct the trouble by stopping coal feed temporarily and slightly reducing air flow.

Number and size of the grinding balls affect capacity and fineness output of the tube mill. A specified weight of different ball sizes is put in the new mill. Add balls periodically thereafter to make up for wear. Keep a record of (1) weight (2) size of balls added (3) level in the mill. Make measurements periodically, when mill is at rest. At longer intervals, usually in connection with yearly boiler overhaul, remove the balls, classify for size, and weigh them. Then add or remove various sizes as needed to come back to the original starting charge. Another indication of the number of balls is the power used when mill is empty.

Tube mill classifiers are usually adjustable, thus providing some control of the amount of coarse coal that is rejected and returned to the mill. Make perodic fineness tests to insure that classifiers are set to give desired fineness at the usual output rate. Regularly on each shift check the conveyors that return the separated coal to the mills; you want to make sure that they are running properly.

If a tube mill is to be shut down for more than a few hours, clean out the coal to avoid possibility of fire. This is most essential with high-volatile coal, but not so necessary with lower volatile coal. If fire starts, flood the mill with water after cutting off the air supply. Then run the unit empty for a period to dry out the water.

Lubricate the gears regularly with

the right lubricant grade and in proper amount. Check trunnion bearing lubrication, even though the mill turns slowly, because these bearings operate under a heavy load. Most trunnion bearings are watercooled to hold the temperatures down.

For most coals, top temperature for the coal-air mixture leaving the mill is 160 to 185 F. Higher temperatures may build up coal deposits in pipes, and cause deposits and fires in burners. Heat for drying coal comes from the energy input to the mill and from incoming air. Motor heat is quite constant, so outlet coal-air temperature must be regulated by varying inlet-air temperature. A tempering damper, usually controlled automatically, admits cool room air to cool the air from the preheater enough to provide the right outlet temperature.

Automatically operated controls should move without undue friction or lost play to avoid temperature swings. You may need a special high-temperature grease or some other means for reducing friction in damper bearings that are exposed to high temperatures and flyash.

Amount of air needed for desired pulverizer output may not be the proper quantity for good burner operation. With high-volatile coals, you often need high velocity at the burners to carry the flame out far enough to prevent burner damage. If coal is soft or dry, you may need only a little air through the mill. Then you can admit additional air for proper burner operation at the exhauster inlet. This is usually arranged to be semi-automatic, subject to manual adjustment.

With anthracite or other very low volatile fuels that are slow to ignite, a separator removes some of the air used for grinding and drying, then feeds it in separately as secondary air. The coal-air mixture is made quite rich so coal burns fairly close to the burner.

Avoid coal spilling around the tube mills for safety and housekeeping. Tighten any loose bolts holding liner plates. Improper operation of dampers admitting air to the mill may cause a pressure that blows coal dust out the small space between trunnion and trunnion tube. Run exhauster fans to keep a good suction on the mill as it is stopped. This prevents spillage from the trunnion opening as the mill rocks to a stop.

Dampers controlling the amount of coal-air mixture removed and air admitted to the mill are usually interlocked. They trip closed if the exhauster differential falls too low, or if power supply to exhauster or mill motor fails. This guards against possible explosion or fire if a puff-back of hot-air flow from the furnace goes through the mill while it is stopped.

Two other frequently used pulverizer types are somewhat similar in principle. These are the bowl and ball mills. In these two pulverizers, coal is ground between stationary mill elements and moving rollers or balls.

Bowl mill uses a number of rollers mounted on a rotating spider and held by spring pressure. They roll against a nearly vertical ring-shaped grinding surface that forms a sort of bowl. Coal feeds into the bowl and is pushed out to the grinding rings by plows. Hot air passing under and around the grinding ring dries the coal, then passes out the top of the mill carrying finely ground particles with it.

Separating cones or baffles mounted in the top of the mill remove over-sized particles and return them for further grinding. Air-pressure drop across the unit is largely determined by the amount of coal in the mill, which restricts the air-flow passages. The pressure drop actuates the coal feed, keeping a small quantity of coal in the mill at all times. When shutting down, run long enough after stopping the feed to empty unit completely.

The motor that drives the mill spider usually drives the exhauster fan too. Quantity of air used, which is quite constant, is set high enough to keep coal-air pipes swept clean. Output is determined by amount of coal fed, rather than by variation in amount of air passing through the unit, as in the tube mill. There is little reserve, so you cannot interrupt coal feed for any length of time without losing the fire. Feeding more coal than can be ground may cause plugging of air passages with resultant loss of fire also.

The mill usually runs under a light suction of 0.5 to 1.0 in. of water. Air supply from the preheater is tempered with cool air as needed to hold the 160-180 F exit coal-air temperature. Controls are usually automatic although they may be manual.

Check drive- and roller-bearing lubrication regularly, and renew the grinding rolls and ring periodically because of wear. Exhauster-fan blades may also wear rapidly; they have to be replaced periodically.

Keep dampers free to move, but without excessive play in the linkage. Pressure-control lines must also remain free and clear.

A pocket or reject spout at the bottom of the bowl is usually provided for accumulating scrap iron, rocks and pyrites that will not grind up. Remove these accumulations regularly, once or twice a shift. You get coal spillage if you feed faster than mill can grind, or air flow can remove.

Ball mill uses a number of large erosion-resistant steel balls running between grooved upper and lower grinding rings or races. One of the rings, usually the upper one, is turned by the driving spider, causing the balls to roll. Entering coal drops onto the grinding race and is pulverized by the balls. One of the rings is spring loaded; thus it can move if iron or other objects caught between the grinding elements cannot be ground. Operation, control and maintenance are generally similar to the bowl mill. Ball mills are more generally operated under pressure, but exhausters are often used.

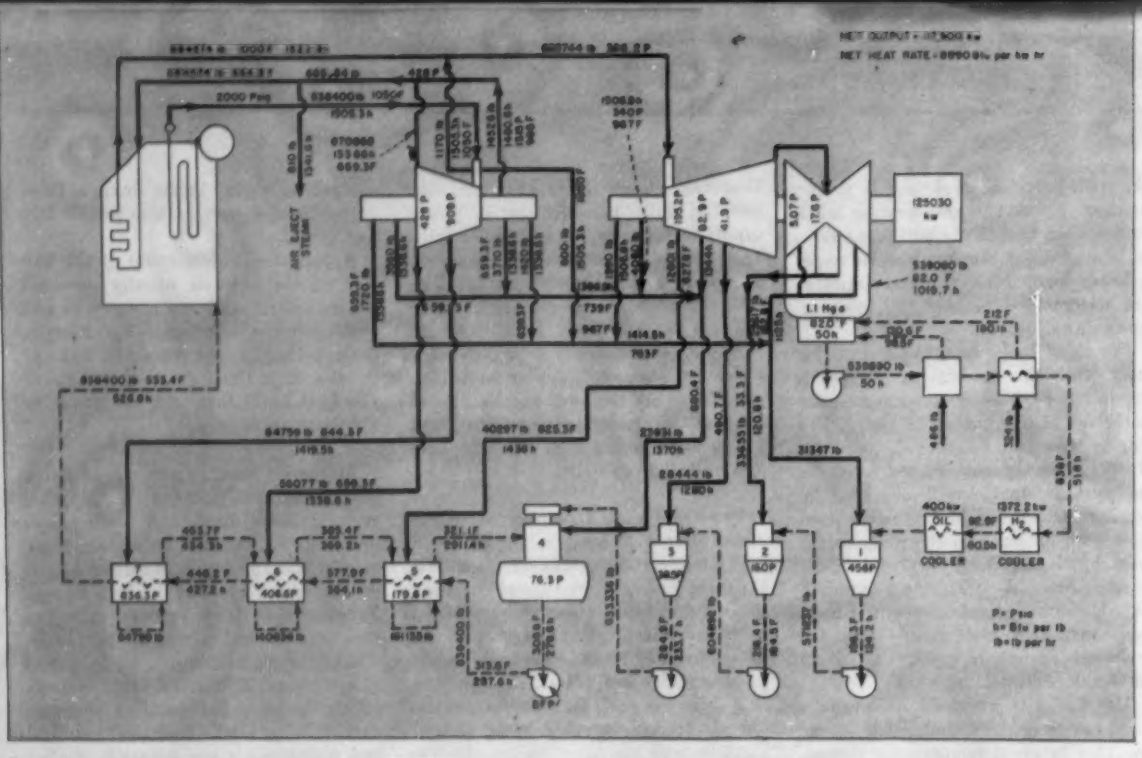
Impact mill operates on the attrition principle. A rapidly rotating member throws coal particles against stationary pegs or lugs in the casing. Coal is pulverized by the impact and by erosion against the mill parts and other coal particles. To operate successfully, coal is best predryed in a separate section of the mill.

After pulverization, the drying air carries coal particles through a classifier or separator for removal and return of the larger particles. An exhauster fan blows the fine coal-air mixture through the burners to the furnace.

Little or no coal storage is available so feed must be continuous to avoid loss of ignition at the burners. Feed in excess of grinding capacity will plug the mills. This may cause motors to trip out on overload, or clutches to slip.

Eliminate tramp iron from the coal feed to avoid damage to pulverizer parts. As parts wear, capacity gradually drops, so grinding parts must be replaced periodically.

Rate of coal feed regulates mill output, while air flow is essentially constant. Variations in classifiers and in air admitted to the mill give necessary velocity of the coal-air mixture in mill-to-burner piping, desired fineness and proper burner stability. Close observation of power to mill motors is helpful in assuring that you have not fed enough coal to overload the equipment.



1 Reheat cycle of modern plant unit uses a 4-stage condensate pump and three contact-type heaters in low-pressure end of feedwater-heating system. Coal-fired heat rate of 8890 Btu per kwhr rises to 9470 with natural-gas fuel feed

Modern controls for today's power plants

This second part gives you more information on control systems of the Raritan River Plant extension of Jersey Central Power & Light Company: their tools for better performance

► WE TALKED about the central control-room arrangement and combustion-control system of the Raritan River Plant extension in August POWER, pp 82-84, 180-182. Now we'll look over the other control systems—some supervised from the central control room and others from instrument and control panels at the equipment.

Steam temperature must be kept as high as possible to maintain high-efficiency operation. Rated temperature can be held on the 125-mw unit down to a load of 90-mw with the aid of gas recirculation. At extreme high loads steam temperature is held down by attemperating between primary and secondary superheaters. No attemperation is provided for the reheat steam.

About half the furnace gas passes over each of the superheater and reheater surfaces. Dampers shunt more or less furnace gas from reheater pass to superheater pass, as needed to hold a substantially constant 50-F difference between the two steam outputs. Excessive reheat is avoided by shunting surplus furnace gas to the superheater pass and increasing attemperating water flow to the superheater.

Eliminating reheat attemperation improves cycle efficiency. Reheat spray water would short-circuit the high-pressure loop of the cycle and cause a thermal loss.

The heavy stainless-steel wells housing the steam-temperature sensing elements cause a thermal lag. This makes the steam temperature oscillate slowly about the set control point during changing loads, but has no effect during steady loads.

Boiler-drum-level control and feedwater control use the conventional 3-element system. But a feedwater regulating valve has been eliminated in favor of variable boiler-feed-pump speed. Electric induction motors drive the feed pumps through fluid-drive couplings. Two of the three pumps can develop full-load flow so a standby regulating valve has not been installed. The E H Werner Station of JCP&L finds this method highly successful. The pumps can be manually controlled locally or from the control room.

Deaerating-heater-level control also uses a pneumatic 3-element system. These three elements respond to feedwater flow, condensate flow and deaerator level. They position an 8-in. diaphragm-actuated condensate control valve in the first-stage discharge of the multisection condensate pump. Under startup or emergency conditions, heater level may be manually controlled from the control room.

This control system was used because of the relatively small storage capacity in the deaerator compared to the condenser hotwell; also, we wanted a con-

SECOND OF TWO ARTICLES

By **ARTHUR J FIEHN**
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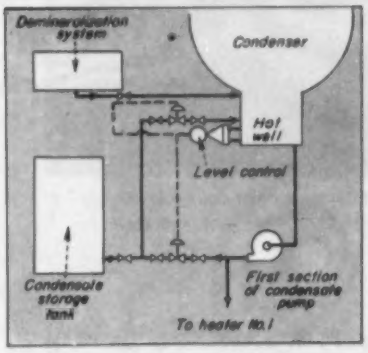
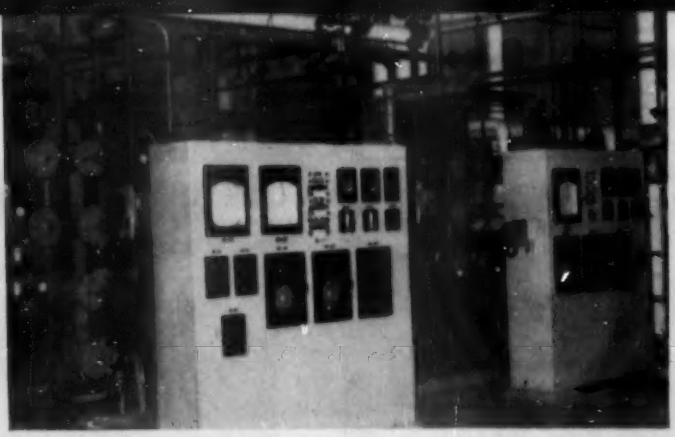
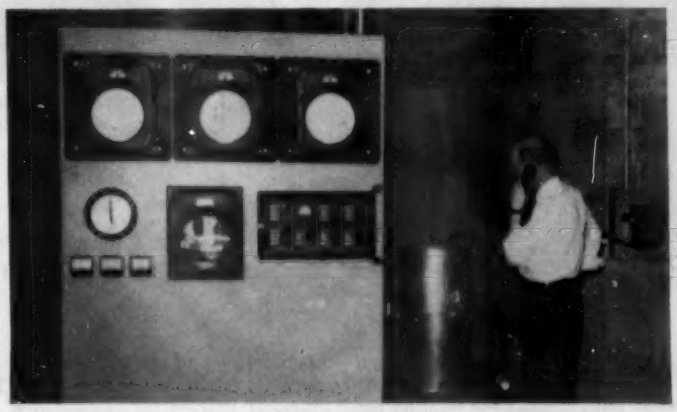


2 Hotwell level controls the condensate flow to and from the storage tank



3 Demineralizing system is run by the basement operator from local panels. Semiautomatic operation and regeneration are started manually



4 Local panels at strategic spots tell operator running status of the equipment. PA system helps communication with plant and control room

stant suction head on the three boiler feedwater pumps.

Hotwell-level control, Fig. 2, has a split-band single-element proportional-band pneumatic controller, sensitive to hotwell level. This controls the position of the valves that govern interchange of condensate between hotwell and storage tank. With normal hotwell level, both valves are closed and no condensate is interchanged. When hotwell level rises, the valve controlling condensate admission to storage tank opens proportionately and restores the hotwell level by bypassing some condensate discharging from the first section of the condensate pump. When hotwell level falls, the valve controlling admission of condensate from the storage tank opens enough to permit restoring hotwell level.

The demineralized makeup has enough dissolved oxygen and CO_2 to be highly corrosive to the condensate storage tank. So it is manually fed to the hotwell for deaeration before starting. Automatic control of hotwell level conveniently transfers the makeup to the condensate storage tank.

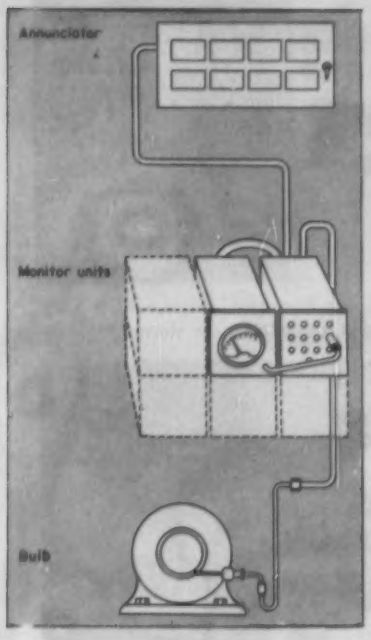
CENTRALIZED MONITORING

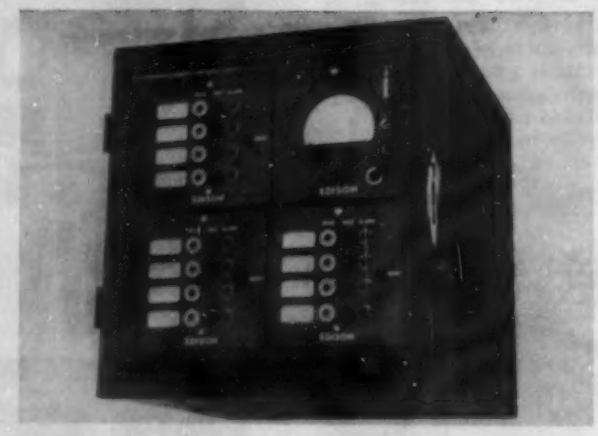
An annunciator with 120 visible and audible alarms monitors the new unit for faulty and off-normal operation. About 90% of these points are used, the rest are spares. Local primary elements (completely independent of those serving control, indication and recording systems) actuate the most vital alarms.

Number of alarm points has been reduced by grouping all related off-normal conditions on one piece of apparatus and connecting to one alarm point. For instance, any one of 80 boiler-tube and drum-metal temperatures will actuate one alarm point. By looking at the multipoint temperature recorder on the rear of the vertical panel the operator can find the exact location of the faulty condition. Similarly, one alarm point signals both high and low level of the city-water tank — the indicator shows which condition exists.

Miscellaneous monitoring. A multibank 140-point temperature scanner and recorder monitors temperatures of boiler tubes, drum metal, and turbine bearings. In addition, this recorder may be used to check rate of turbine-shell temperature rise during startup. Any or all banks (20 thermocouples in each bank) may be selected for constant recording, or the instrument may be operated to simply scan all points, recording only those rising high enough to signal an alarm. The operator may also select any one point for constant recording as needed. Except during start-up, this instrument would be set to record the bank handling turbine bearing temperatures and scan the remaining banks.

Bearing temperatures. High investment, operating and maintenance costs of the main turbine made it desirable to record turbine-bearing temperatures as just described. To do this for all rotating auxiliaries would be costly. To establish continuous monitoring we set up local areas. For instance, there is a compressor area, fan area, boiler feed-pump area, circulating-pump area, etc. In each area locally mounted bearing-temperature indicators continually monitor each bearing. A high bearing temperature immediately actuates an alarm circuit for that area and the con-





5 Temperature monitoring unit allows economical supervision of many critical points in the plant, has just one meter

← 6 Monitoring unit ties in parallel with annunciator in central control room, and uses one meter to read many points

trol-room annunciator signals a high bearing temperature in that area. At the same time, a small red light on the local panel shows the exact bearing at fault. The roving operator plugs in a jack and reads the temperature. Fig. 5 and 6 show a typical panel and the Edison Monitoring System.

Ash-handling system removes chilled slag from two tanks and flyash from hoppers on the boiler and air heater. Slag removal by the wet-sluicing system uses Hydro-jets and the dry flyash system uses a Hydro-veyor. The ash-handling control panel stands next to the pumps supplying water to these systems.

The slag-removal system uses three classes of service water. These are controlled from the panel with appropriate gages. Removing slag from the slag tanks is largely a manual operation at the tanks, about 20 ft from the panel. The automatic flyash-removal system needs only the operation of the high-pressure-service-water pump and remote water valves from the panel. An alarm signals the end of the hopper-emptying sequence. The pump must be started and stopped manually.

Demineralizing system, Fig. 3, is controlled by the basement operator from the panels shown, a Cation Panel and an Anion Panel. The demineralizer tanks with their piping, valves and panels stand in the basement and the chemical storage and mixing tanks are on grade in a separate lean-to structure adjacent to the main building. This eases delivery of chemicals and avoids chemical mixing inside the plant. The chemical charges for regeneration are mixed during the day shift to have them available whenever needed.

The semiautomatic twin-bed demineralizer and the regeneration cycle must both be started manually. An air-operated level control keeps the 100,000-gal city-water storage tank full. City water flows by gravity through the demineralizer to the condenser, Fig. 2. The flow rate is set manually at the optimum for the number of demineralizers in service. When water demands are satisfied the high-level alarm signals and the demineralizer must be stopped manually.

Rising solid content of the water automatically takes the demineralizer out of service and sounds an alarm. When needed, regeneration must be started manually and cycle timers carry on regeneration, backwashing, etc, sounding alarms when the unit is ready for service.

Boiler-water treatment. The chemical feed pumps stand in the basement next to the demineralizer panels. Their mixing tanks stand next to the demineralizer mixing tanks in the lean-to. Chemical charges are mixed in batches and the basement operator feeds the solution as scheduled by the chemist. Water condition at many points in the cycle is recorded in the control room.

Lubricating-oil conditioning. The turbine-oil reservoir stands on a platform midway between operating and basement floors. Oil conditioner and precipitation tanks stand on the basement floor. Pumps circulate oil through the conditioner and transfer it between various tanks. The basement operator controls the valving and motors from the basement floor.

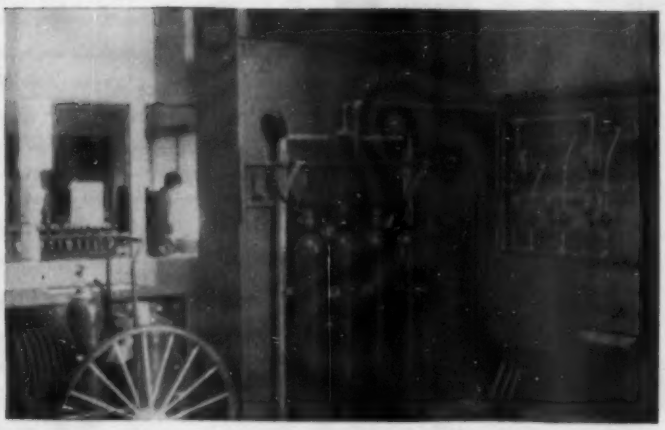
Hydrogen seal-oil unit and hydrogen control panel are both in the basement under control of the basement operator. Some of the panel indications are duplicated in the central control room.

The gas dryer, water detector and generator purge panel are in this area, but the CO_2 and H_2 bottles stand in a separate small building bordering the road where truck deliveries are made to the chemical mixing house. The storage house has a plank deck to facilitate safe delivery of bottles with a minimum of handling. H_2 and CO_2 are piped into the purge panel.

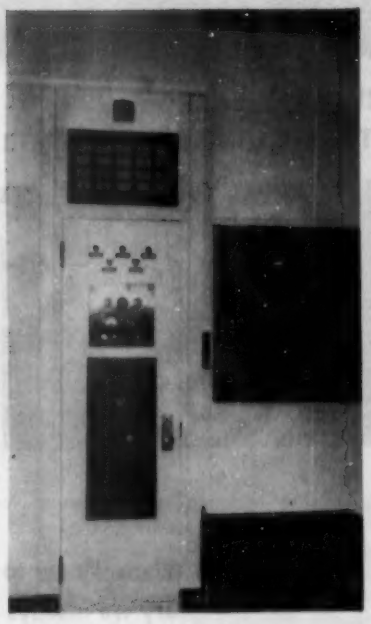
Communications. The central control room is manned continuously while the local control stations are manned as needed. A reliable communication system is vital to direct the operators, particularly during emergencies.

Three communication systems serve the plant: (1) N. J. Bell Telephone System with outlets in the offices of key personnel and main control rooms (2) PAX system with many outlets in all parts of the plant (3) PA system with outlets throughout the production areas of the plant.

The Bell system is for outside com-



7 CO_2 bottles in rack serve fire-control blanketing system in turbine-oil reservoir, purifying unit and the oil-system precipitation tank



8 Fire-control panel in centralized control room shows automatic operation of fusible links on annunciator, has buttons for manual control →

munication only. The switchboard room uses the intersystem carrier-current radio system for communication with other plants and load dispatcher. In addition, direct lines are available throughout the system.

The PAX system is used for all non-operation business of the plant, such as maintenance, personnel, personal, etc. A code-call system notifies anyone in the plant away from his manual station. The PAX system backs up the PA system when needed for operations.

The PA system has speakers and handsets throughout the plant, Fig. 4. This keeps all operators aware of events in any part of the plant. Pressing a button on the sending handset can bring any selected speaker into operation for a 2-way conversation without broadcasting throughout the plant. However, an emergency broadcast can be sent over all the speakers by any handset, when a 2-way conversation is under way. Handsets at control stations have extension cords so operators can carry on conversations while making adjustments, taking readings, etc.

Fire control, for the plant extension, centers in the control panel in the central control room, Fig. 8. The panel for the next 125-mw extension will stand adjacent to this one. The turbine-oil reservoir, purifying unit and precipitation tank all have a CO_2 blanketing system. This system can be discharged automatically by fusible links, or by a hand release at the fire-control panel. An annunciator drop indicates operation of the system.

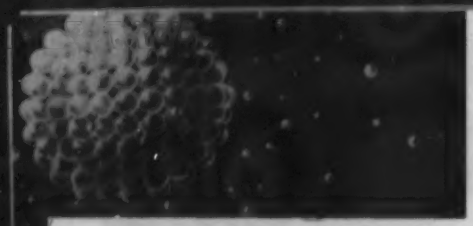
A dry-chemical system discharged by an ROR (rate-of-rise) actuator protects turbine bearings and under side of turbine. This system can be discharged also from the fire-control panel with an annunciator drop indicating operation. A fire-fog system protects most of the entire volume below the turbine-room operating floor. Nozzles are particularly located over oil tanks and equipment and where oil lines stand close to steam lines.

These fog nozzles are grouped into four systems, each controlled by ROR actuators. These fog-nozzle systems can be actuated from the fire-control panel or the auxiliary fire-control station in the basement. There is a separate and distinct fire-alarm system in this plant that cannot be confused with the other alarm systems. The fire pump for the plant is started from the fire-control panel. It can be started locally if needed.

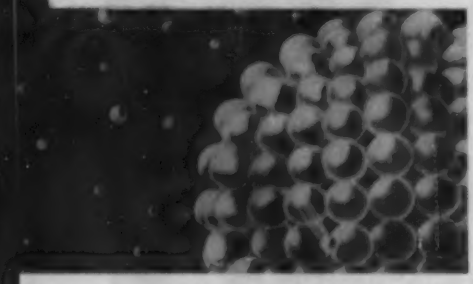
Future design. In the next plant of similar design we would tend to increase the use of the annunciator and use read-out printing for permanent log records. In addition, we would have miniature trend recorders for operating convenience. Such an arrangement would permit continuous-performance computing instruments to be added later when data accuracy warrants their introduction. A combined control console and vertical instrument board seems best suited to this arrangement even though this raises several practical problems not yet fully determined.

More radical instrument changes are likely in the distant future. Development of digital and analogue computers and read-out printers may justify their application eventually to continuous computation of plant heat rates, and efficiencies of boiler, turbine, feedwater heaters and other major equipment. Applications of these devices on a system-wide basis may permit automatic load dispatching on the basis of unit efficiencies as they actually exist rather than from past test records. Such records should quickly detect equipment deterioration and operating malpractices. Adapting manufacturing programming methods may insure uniformly perfect startups and shutdowns.

Using these techniques will require changing the conventional structure of plant organization—the results and operating departments will be one and the same. Instrument and equipment manufacturers must continue striving to increase accuracy, stability and reliability of their instruments—particularly the primary sensing elements. The instruments used for results work will also be the operating control apparatus. Application of similar instruments to the distribution phase of electrical-power supply has demonstrated their worth; it remains to feed them with sufficiently accurate data to reduce costs on the production phase.



NUCLEAR-ENERGY STUDY COURSE: NUMBER 13



A SAMPLE FUEL PIECE
Before insertion in reactor
After a certain exposure in the reactor
After twice as much exposure
THE SAME TYPE FUEL PIECE METALLURGICALLY TREATED
Before insertion in reactor
Same exposure as above
Same exposure as above

REACTOR FUEL PIECES, with service, become damaged from neutrons and radioactivity, treatment lengthens the fuel life as found in experiments by Argonne National Laboratories

When we try to apply new principles discovered in the laboratory we always run up against tough problems in making them work. In our new atomic plants we have trouble with radioactivity and finding . . .

Reactor materials to do a tough job

By **HENRY C SCHWENK,** *Henry Pratt Company*
and **ROBERT H SHANNON,** *United Engineers and Constructors, Inc*

► CHOOSING THE MATERIALS best suited for severe service in nuclear reactors proves one of the most difficult problems in design. Table 1 lists the variety of components in a reactor using different types of materials.

Neutron flux and gamma rays damage the materials by (1) displacing atoms from their locations in molecules and crystals (2) transmuting the material from one element to another—by absorption of a neutron. Neutron damage depends on the total dosage measured by nvt: where n represents total number of neutrons in dose, v the neutron average energy or velocity, t the total exposure time.

Materials attenuating gamma rays become heated, causing thermal gradients and stresses in their bulk. Properties of materials affected by neutrons and gamma rays include: *Mechanical properties*—hardness, tensile strength, impact strength, fatigue strength, ductility; *Physical properties*—density, expansion coefficient, thermal conductivity.

In addition to radiation exposure, some parts of reactors and coolant systems must be able to stand up under thermal shocks developing in seconds. The frequency of these shocks becomes a matter of probability in designing the reactor plant.

Fuel materials. For solid-fuel reactors the fissionable material may be in many forms:

1. Natural uranium with 0.7% of U-235.
2. Natural uranium enriched with U-235 up to more than 90%.
3. Natural uranium alloyed with zirconium, molybdenum, chromium, or other nonfissionable element.
4. An oxide of uranium such as UO_2.
5. Th-232 and U-233 mixed in various proportions. Remember, U-233 transmutes from Th-232 after neutron absorption and decay.
6. Pu-239 alloyed with U-238, Th-232, zirconium, molybdenum, chromium, or other nonfissionable element.

Reactor life of a fuel element, the time it can be left in the reactor core, depends on: (1) *burn up*, the percentage of total fuel atoms that have fissioned (2) *fission product* yield (3) *pressure build-up* where some of the fission products may be in gaseous form (4) *xenon build-up*, a fission product which avidly absorbs neutrons and may delay restarting a thermal reactor after a shutdown. Capture cross-sections of all fission products must be studied by the reactor designer.

Because in many solid-fuel reactors the fuel elements do not carry a mechanical load, the primary properties that must be satisfied are: (1) density (2) dimensional stability (3) thermal conductivity. Fuel elements are sometimes clad for protection—if not, the designer must be concerned with the ability of the fuel to withstand corrosion and mass transport by the coolant

1: Principal reactor elements

1. Fuels (alloys, diluents, etc)
2. Structural members, fuel-element cladding, reflector
3. Piping
4. Equipment components (controls, instruments, pumps, heat exchangers, valves, traps, etc)
5. Coolant-system fluids
6. Thermal insulation
7. Electrical insulation
8. Bearing lubricants
9. Moderator and shielding

2: Materials used for reactors

CLADDING	REACTOR VESSEL	COOLANT SYSTEMS*
Stainless steels	Stainless steels	Stainless steels
Zirconium	Type 304, 316,	Type 304, 316,
High-purity iron	347, etc	346, etc

*Water and liquid metals

fluid. Fig. 1 shows how fuel elements may be affected by radiation exposure.

All the above factors do not apply to liquid-fuel alloys, solutions and slurries. The biggest problem for these fuels concerns finding materials that can stand up under the corrosive and mass-transport action. We believe this type of fuel will prove feasible eventually—it has a big advantage of offering continuous processing to remove fission products and add new fuel.

Reactor components. The primary requirements of structural, cladding and piping materials include:

1. High allowable tensile and compressive working stresses.
2. High resistance to corrosion and mass transfer by reactor coolant.
3. Minimum damage from nuclear radiation; in other words, density and dimensional stability, minimum reduction in thermal conductivity (especially in cladding) and minimum loss in tensile and compressive working stresses.
4. Good cold and hot ductility to withstand thermal shock.
5. Good fabrication characteristics—welding, machining, workability, grain-size control, heat treating to control grain size, stress relieving.
6. Low neutron-capture cross section.
7. Availability and reasonable cost.

Reactor life time of a fuel element affects the thickness of cladding material chosen to cover it. This, in turn, depends on corrosion and mass transport of the coolant. Table 2 lists various materials used for reactor elements. Cladding material must have a good thermal bond with the fuel alloy, except for the refractory type, such as UO_2. This can be done by having a good molecular diffusion bond at the contact surface, or possibly by a liquid-sodium penetrant-type bond between fuel and inner surface of the cladding. The fuel-element unit-assembly void could be filled with liquid sodium before seal welding. Removing the cladding during processing of spent fuel elements poses an additional problem.

Materials in Table 2 apply particularly to solid-fuel reactors and those using water and liquid metals (Na and NaK) for primary and secondary coolants. These materials are all rather expensive, but can stand up under heat and nuclear radiation. We hope that eventually low-cost low-alloy materials can be used for radioactive-sodium coolant systems.

Steels. Carbon steel has been used only at low temperatures for liquid metals (sodium at 300 to 400 F) and for steam-plant feedwater systems. Graphitization limits this material to a top of about 750 F.

Low-alloy steels (1-2½ Cr and ½-1 Moly) are used up to 1050 F for steam plant service. To date we have no long-time experience with these in handling liquid metals. Current test programs should supply the answers.

The stainless steels, Type 304 (ELC—extra low carbon), type 316 and type 347 (columbium or niobium stabilized) have been used for liquid-metal systems. The latter has been used much more than the others and also for the pressurized water coolant systems of thermal-type reactor plants.

Structural, containment materials. Their selection depends on these factors: (1) strength (2) creep (3) fabrication (4) cold and hot ductility (5) ability to heat-treat (6) cost (7) thermal conductivity (8) stability under nuclear radiation (9) previous experience under service — neutron flux, gamma-ray heating, coolant fluid, thermal shock (10) resistance to corrosion and mass transport. These are not listed in order of importance.

Accessibility to repair weld or material failures in a reactor is doubtful because of radioactivity. Long delay periods may be needed to allow radioactivity to decay to safe levels for personnel making the repairs.

Material costs must be considered carefully. Stainless-steel plate is about 10 to 12 times more costly than carbon-steel plate and about 6 to 8 times more than low-alloy-steel plate. In small tube and pipe sizes, these factors may drop to 8-10 and 4-6, respectively. But, remember, material cost alone is not a true comparison; split between material and fabrication costs of a heat exchanger may be 50-50. For a piping system costs of material thickness at welded joints, lineal feet of welding and weld preparation and heat treatment may be more than the material cost.

Selecting materials for reactor plants becomes a matter of engineering judgment and evaluation based on available experience and service data, applicable engineering and stress theory, and metallurgy to give the maximum in predicted plant reliability. Type 304 ELC (or 304 L) stainless steel has a maximum carbon content of 0.03% by weight. Allowable working stresses are considerably less at higher temperatures than for commercial grade Type 304, which has carbon of about 0.08%. But Type 304 ELC is not as subject to forming carbide stringers in the grain boundaries (sensitizing) with loss of strength and ductility as commercial-grade Type 304 at around 1000 F.

Type 304 commercial grade is better than Type 347 stainless from the standpoint of cold and hot ductility. These properties permit a material to stand up better under thermal shock. This is more important in liquid-metal systems. For strength, Type 347 is better than Type 304 commercial, especially at higher temperatures. The columbium prevents the formation of carbide stringers in the grain boundaries.

Weldability of Type 304 versus Type 347 is a moot point among metallurgists

Radioactivity complicates reactor designer's job

and welding engineers. We hope additional experience will give more concrete answers.

All material should be tested ultrasonically before (and maybe even after) fabrication of equipment. For some forgings and castings it may be necessary to depend entirely on X-ray and gamma-ray examination. Surface cracks should be searched for by magna-fluxing or fluorescent liquid penetrant testing.

Corrosion and mass transport. Corrosion depends on:

1. Containment material — pressure vessel, fuel element cladding, piping.
2. Fluid used as primary coolant.
3. Maximum temperature of surface in contact with coolant fluid.
4. Fluid quality: *water*—total solids, dissolved oxygen, pH level; *sodium*—primarily oxygen content.
5. Material surface finish.

Mass transport through a fluid loop depends on the same factors as corrosion plus the temperature difference between the hot and cold legs. Amount of foreign material that the coolant holds in solution depends on the fluid temperature; for example, sodium may pick up iron, nickel or chrome.

The mechanics of mass transport work like this: (1) Primary coolant heats up while passing through reactor. (2) The heated coolant dissolves some of the containment materials to reach a so-called saturated state. (3) Coolant enters heat exchanger to give up heat and be cooled. (4) As coolant temperature drops, the amount of dissolved material that can remain in solution decreases. In this way material picked up in the hot leg of the loop deposits out in the cold leg.

These deposits can form in any section of the cold leg. If the reactor inlet plugs up, sections of a solid-fuel reactor might melt from overheating.

Amount of material removed in the hot leg poses a problem, especially for fuel elements thinly clad. Cladding thickness depends on time the fuel element is expected to stay in reactor.

Cold traps in the cold leg of the coolant loop may be a section of pipe or special equipment designed to hold the insoluble impurities as they drop out. Two types are used in sodium and other liquid-metal systems: (1) *Diffusion*—removes impurities by molecular diffusion in a colder region. (2) *Circulating*—part or all of the coolant flows through a vessel packed with stainless-steel wool, the sodium is cooled below the main-system cold leg temperature. Micrometallic filters have been used with both water and liquid metals.

Thermal transients, or shocks, produce suddenly increased thermal gradients. Severity of the shocks depend on: (1) rate of temperature change (2) duration of transient (3) total temperature change (4) type of material (5) material thickness (6) thermal conductivity of material (7) stresses in material at start of transient caused by pressure, normal temperature difference, external connection restraints and thermal expansion (8) fluid producing the thermal transient.

Metals subjected to thermal shocks should have good ductility. Conditions causing thermal shocks include:

1. Reactor scram (fast shutdown) with the primary coolant pumps still running.
2. Reactor excursion (power overshoot) with and without primary coolant pumps running.
3. Failure of secondary coolant-system pump in a 2-loop system, see POWER, May 1955, Part 10, p 95.

Type of coolant becomes specially important during thermal transient conditions because of the temperature effect at the contact surface between material and fluid. For sodium the temperature changes much more rapidly because of the high film heat-transfer coefficient and the high thermal conductivity of the liquid metal. This causes rapid changes in the temperature differences across the material and hence raises thermal stresses.

With water the lower film heat transfer coefficient mitigates the effects of thermal transients, other things being equal. Circuit time (time required for a fluid particle to make one trip through the loop) affects the rate at which transients hit the material in various parts of the system. Another consideration, difficult to estimate, concerns the number of thermal shocks a plant may experience during its life. This differs for each plant and system.

To select materials for withstanding thermal transients we must evaluate:

1. Allowable working stress at maximum temperature conditions.
2. Required material thickness based on pressure and temperature conditions.
3. Magnitude of gamma-ray heating as function of material thickness.
4. Thermal conductivity and temperature difference across material.
5. Thermal stresses created by items 1 to 4 just described.
6. Cold and hot ductility of material.

Design codes. Available codes like *ASME Power Boiler* and *Unfired Pressure Vessel Codes* do not cover the service conditions under which the materials must run in a nuclear power plant. Additional factors that must be considered include:

1. Increased magnitude, severity, and total number of thermal shocks and effect on material life.
2. Effect of nuclear radiations on material properties.
3. Effect of integrated neutron dosage over expected material life.
4. Effect on choice of materials of various long half-life elements, such as tantalum, manganese, cobalt, etc, found in certain alloys.
5. Effect of thermal heating in material by gamma-ray attenuation.
6. Better material selection and quality control.
7. Increased severity of corrosion and mass transport problems.

These factors may give us new concepts for arriving at allowable working stresses and life factors for materials in nuclear power plants. Some work is now under way, and more must be done to aid the reactor design engineer.

Coolants. We talked about characteristics of various fluids as coolants in Part 9, April 1955, p 89-91. Since water and sodium are the most likely candidates for solid-fuel reactors, let's compare their flow characteristics for use in a reactor.

Water. High vapor pressure-temperature relation makes cavitation a problem. To minimize cavitation, system must be pressurized and fluid velocities kept fairly low. Cavitation takes place where the local absolute pressure in a fluid stream is less than the saturation pressure corresponding to the local fluid temperature. A sudden change in flow-channel section that increases fluid velocity can drop the absolute pressure sharply.

Sodium. At atmospheric pressure, sodium boils at 1620 F, compared to 212 F for water. We won't have cavitation troubles in a liquid-sodium system to the extent they may occur in water. Sodium velocity is limited by erosion effects and pumping power. Sodium velocities of 30 to 50 fps appear feasible for the reactor core, and 20 fps or higher in the piping system.

Pumping and other flow characteristics of water and sodium are fairly similar. Their fluid kinematic viscosities

(*Continued on page* 198)

MOTOR-DRIVEN EXCITER at Danskammer Station of Central Hudson Gas & Electric rated 200 kw, 250 v, 1200 rpm. Unit supplies dc to 66,000-kva generator

Here are some of the reasons why fewer shaft-driven generator exciters are being installed: An accounting for . . .

The shift to motor-driven exciters

By V C STRODE

Large Motor & Generator Dept
General Electric Company

► MOTOR-DRIVEN EXCITERS have cornered many advantages over generator-shaft-driven units, accounting for their increased use. Typical: Separate motor-driven exciter for turbine-generator trims over-all length of generating unit. And, not being mechanically connected to the turbine-generator, the motor-exciter may be located to conserve floor space. Exciter maintenance is also a factor. Any extended maintenance on a shaft-driven unit requires shutting down the prime mover and generator. Not so with separate motor-driven units.

Most exciters in use today are special dc generators, but static rectifiers may be used. Rotating exciters have been coupled directly, geared, or overhung on generator shaft on many of today's generators. However, with the increased need for greater quantities of dc as main generator size increases, it is often impractical, and sometimes impossible, to build bigger dc machines to run at main generator speed. Hence, reduction gears or a motor-driven exciter permits designer to select optimum speed for best exciter operation. Although large and small turbine-generators use motor-driven exciters, they have seen widest application with larger generators where direct-driven exciters are not satisfactory.

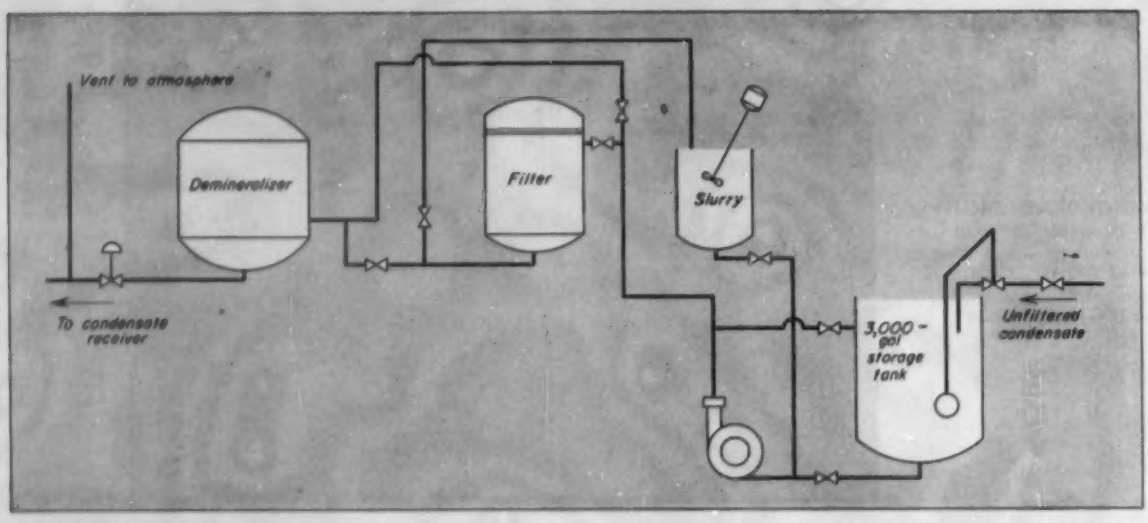
The separate motor-driven exciter was introduced years back as a spare or standby unit. Only in recent years has it found wide use as main excitation source.

Exciter requirements are pretty much agreed on. Minimum kw rating is determined by ASA standards according to main generator field requirements. Ceiling voltage, the maximum voltage an exciter will reach when operating under specified conditions, is an important characteristic. Exciter voltage response and exciter stability are also key characteristics. Exciter must be able to withstand sudden output demands up to four times exciter rating for a short period. These are but some of the characteristics that apply to all exciters in the power-generation field.

Other characteristics apply only to motor-driven exciter, assuring equivalent performance whether exciter is driven off turbine-generator shaft or by a separate motor. Motor-driven set must be capable of delivering ceiling excitation and response for sustained motor terminal voltage as low as 70% rated voltage. With generator exciter set output held constant at rated load, motor is subject to a 2-second throwover to voltage source 70% of rated: Exciter must recover to rated speed. For all typical system faults, including a 3-phase fault at the high-voltage bus, permissible fault-clearing time has to be equivalent to that of a turbine shaft-driven exciter.

Without delving into details of interest mainly to the exciter designer, we will state that standard industrial m-g sets will not meet the requirements of turbine-generator unit. A motor-driven exciter used as the main excitation source for turbine-generators must be designed for this specific application.

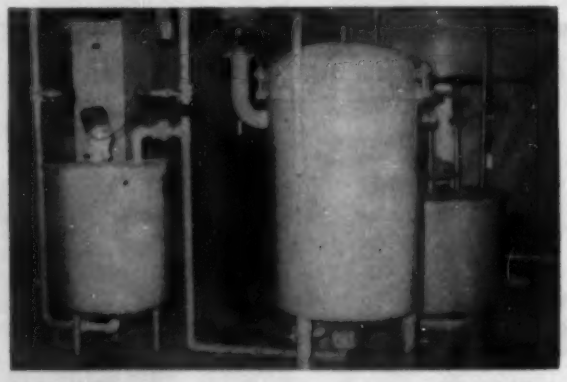
Typical construction utilizes a common base for motor and exciter. Both units are then enclosed in a steel housing, designed for quick access to either machine. Cooling scheme depends on user's requirements. Intake louvers may be below-floor or in the housing's side, near the top. Openings high in housing reduce amount of floor dirt sucked into machine. Air-discharge is generally on top of housing, sending air upward through screened passages. Resistance-temperature detectors in air inlet and discharge warn operator of trouble.



CONDENSATE FILTRATION setup at Toledo Edison's Acme Station removes oil, dirt without chemical treatment, coagulation

Diatomite filter-aid protects high-pressure boilers against oil

By **C C SPILMAN**, *Chief Chemist*
Toledo Edison Company
and **H KRANICH**, *Sales Engineer*
Johns-Manville Corporation



FILTER UNIT and slurry tank use only about 50-sq-ft floor area. Filter materials cost just 2.1c per thousand gallons

► USING DIATOMITE as a filter-aid in pressure filters to remove oil from condensate is not new. But only recently has there been such an installation in a major power-generating station where condensate feeds high-pressure boilers.

Toledo Edison Company installed two 900-psi boilers to serve their new 100-mw turbine early in 1949. These boilers could provide 100,000 lb per hr of steam in excess of amount needed for the new turbine. So in 1953 it was decided to use this excess steam to supplement that provided by 12 older low-pressure boilers. Steam, reduced from 875 to 235 psi, goes to turbines 1, 3 and 4, is condensed and collected in 3000-gal storage tank.

Condensate return from low-pressure system is contaminated with oil from oil-cooled turbine bearings and with algae, slime, rust and scale from raw river water used for condenser cooling. These impurities had to be removed before condensate could be used for high-pressure boilers.

Filtration proved the best answer to the contamination problem. Low-pressure system condensate was sent through a horizontal - plate pressure filter, coated with specially treated diatomaceous-earth filter-aid. This clarification scheme was chosen after considering various older methods—all calling for chemical treatment and coagulation. Diatomite filtration needs no such pretreatment, nor does it need skilled labor for pH control.

There is no increase in solubles due to filter-aid. And filter can be operated intermittently without danger of oil or solids break-through.

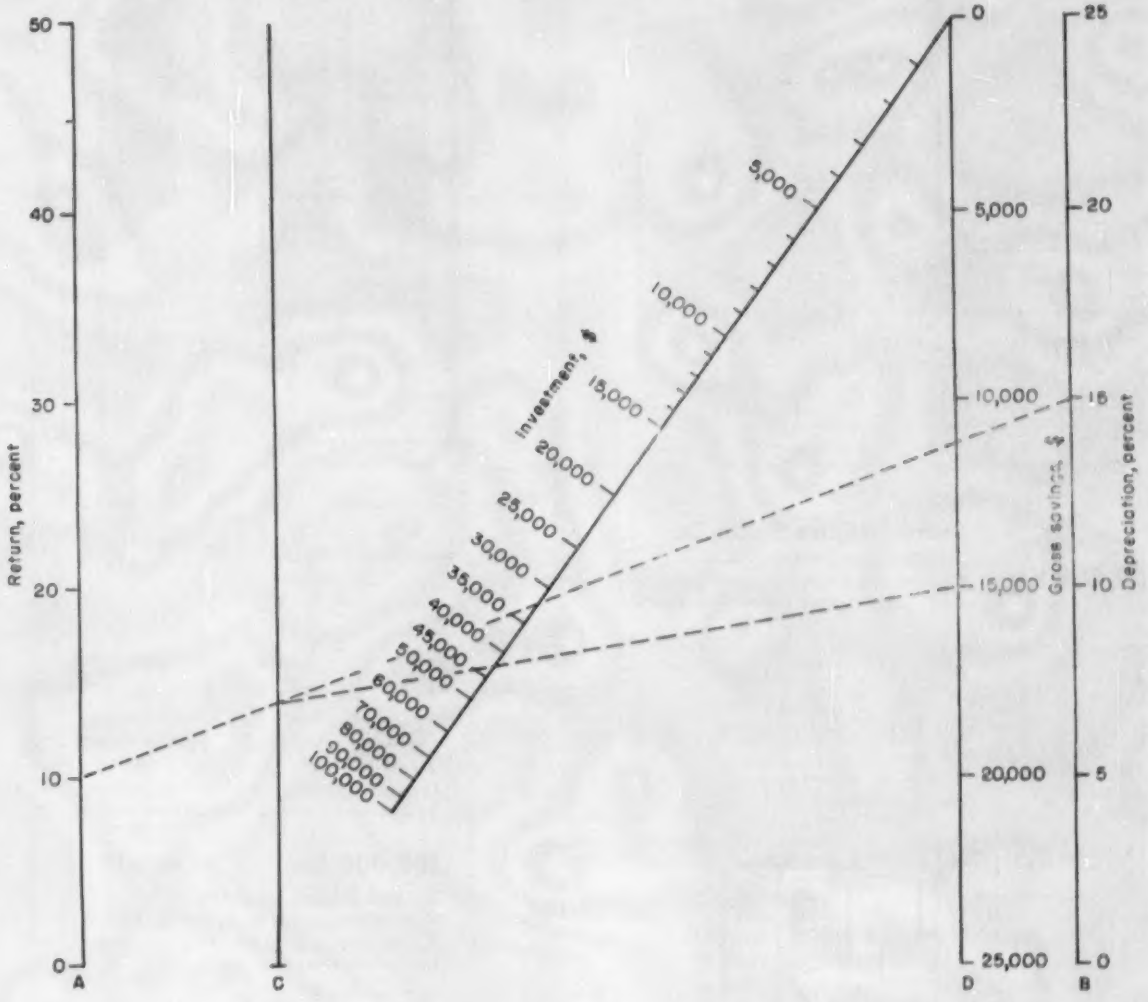
Filter elements are horizontal perforated disks with disposable filter paper—effective area is 151.2 sq ft. Filter goes between storage tank and demineralizers, and needs no additional pump. Slurry tank has an agitator.

Filter papers are coated with 25 lb of diatomaceous-earth filter-aid by circulating from and returning to the slurry tank. Procedure takes about 5 to 10 minutes, and filter produces clear condensate right after it is put in operation. This specially treated filter-aid removes free and emulsified oil. It breaks any emulsion present and, by a combination of absorption and adsorption, retains oil in filter cake. Overlapping and interlacing diatomite particles trap out the smallest of solid particles.

On the average, 390,000 gallons of condensate are filtered per cycle—or 2560 gallons per sq ft of filter area. Temperature variation has presented no operation problem. At the end of the cycle, filters are removed and new ones put in. The entire operation takes two men only 2½ hours to perform.

Power's DATA SHEET

No. 279



Annual savings, return and depreciation fix justifiable investment

► COMPANY POLICY usually fixes the percent return on an investment needed to justify spending money to gain a saving in labor or material costs. This nomogram helps figure the investment justified by a gross annual saving assuming a percent return, a percent annual depreciation charge, and a 50% federal tax on net savings.

The nomogram is based on the formula:

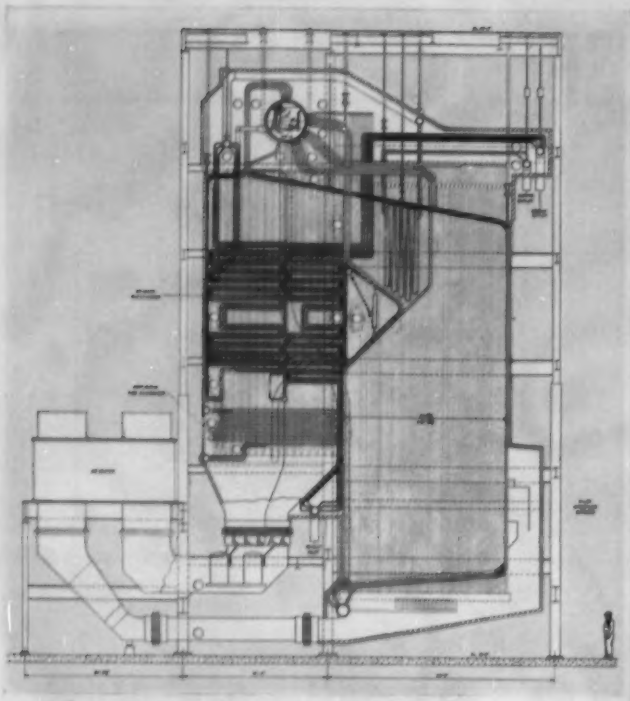
$$\text{Return} = \frac{(\text{gross savings} - \text{depreciation rate} \times \text{investment})\ (1 - \text{federal tax})}{\text{investment}}$$

Example: Find the justifiable investment for a gross annual saving of $15,000 when a return of 10% and a depreciation rate of 15% are specified.

1. Draw a straight line between 10% on the *A* scale and 15% on the *B* scale.
2. From the intersection with the *C* scale draw a straight line to $15,000 on the *D* scale.
3. At the intersection with the inclined scale read the answer of $43,000.

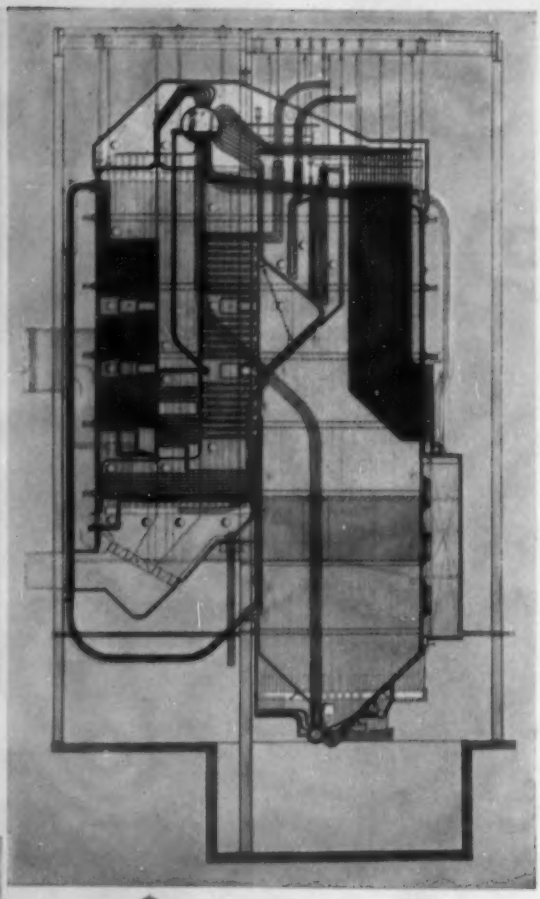
G A LARSON — *Collinsville, Va.*

© POWER



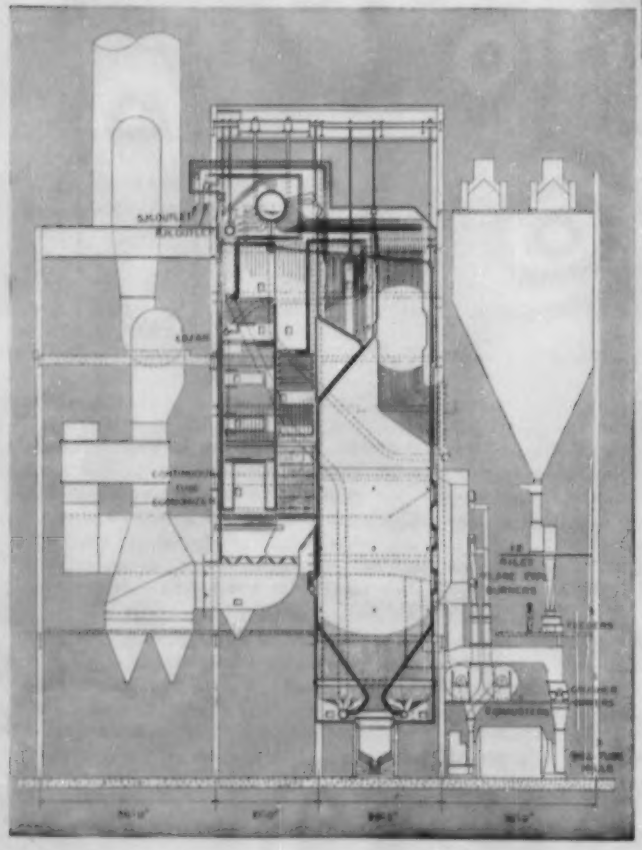
50,000 Kw

Central Louisiana Electric Co.
Teche Station, Baldwin, La.
Capacity 350,000 lbs/hr; 1500 psig; 1005F/1005F
Fuel: Natural gas; Pressurized Furnace



75,000 Kw

Florida Power Corp.
Ellaville, Florida
Capacity 600,000 lbs/hr; 1550 psig; 1000F/1000F
Fuel: Oil and Future Coal; Pressurized Setting



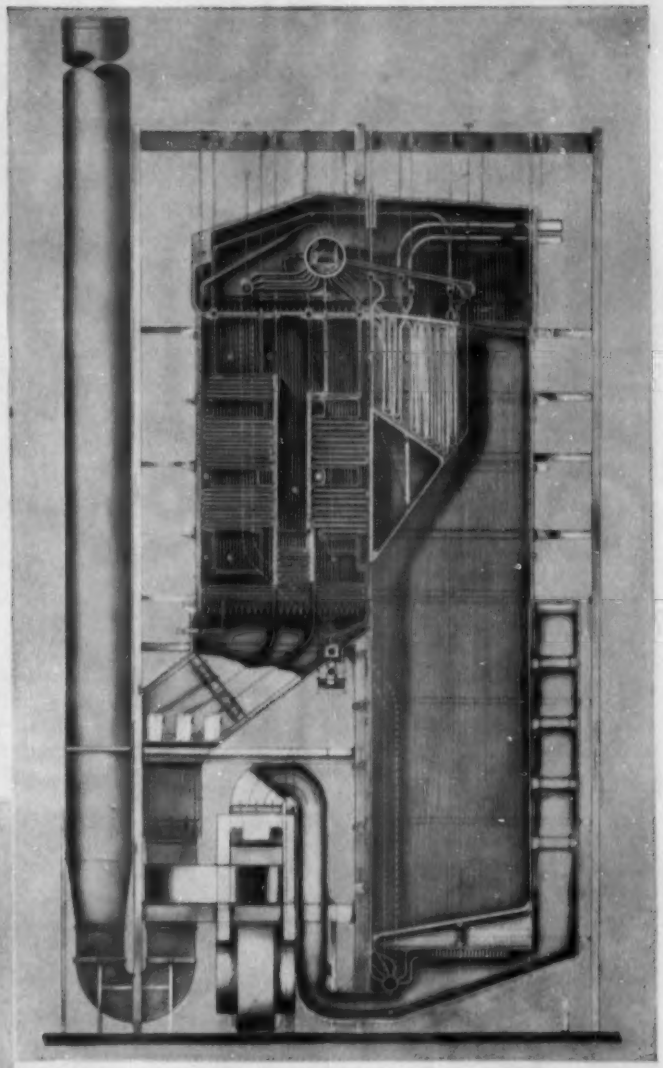
100,000 Kw (Not illustrated)
Central Illinois Light Co.
R. S. Wallace Station, E. Peoria, Illinois
Capacity 690,000 lbs/hr; 1650 psig; 1000F/1000F
Fuel: Pulverized Coal

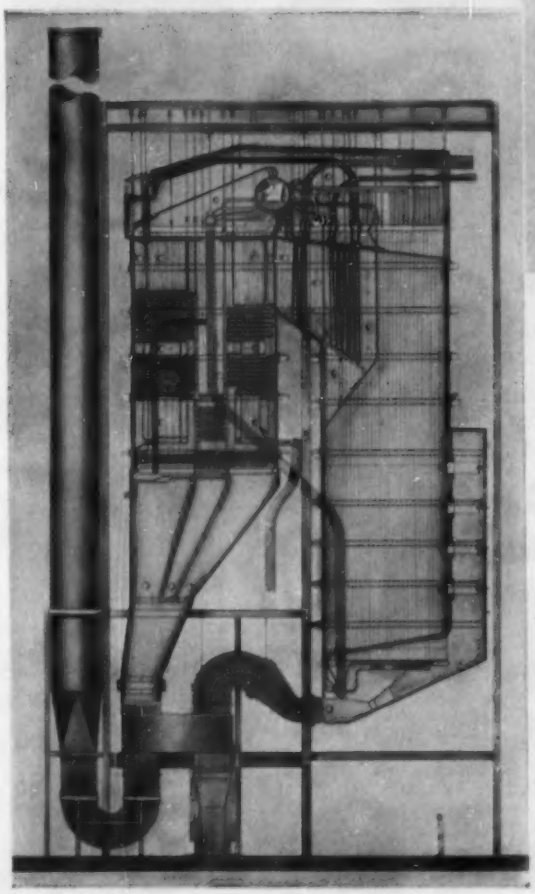
125,000 Kw
Public Service Co. of Indiana, Inc.
Wabash River Station
Capacity 805,000 lbs/hr; 2075 psig; 1005F/1005F
Fuel: Pulverized Coal

150,000 Kw (Not illustrated)
Public Service Co. of Indiana, Inc.
New Albany Station, (2 units-total-300,000 Kw)
Capacity 1,000,000 lbs/hr; 2075 psig; 1005F/1005F
Fuel: Pulverized Coal; Pressurized Furnace

125,000 Kw
Louisiana Power & Light Company
Nine Mile Point Station.
1,000,000 lbs/hr; 1725 psig; 1005F/1005F
Fuel: Natural gas; Pressurized Furnace

RILEY
Reheat Units for Turbine Ratings from 50,000 Kw up to 175,000 Kw





175,000 Kw

Houston Lighting & Power Company

Deepwater and Sam Bertron Steam Electric Stations
Capacity 1,250,000 lbs/hr; 2125 psig; 1005F/1005F
Fuel: Natural gas; Pressurized Furnace

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

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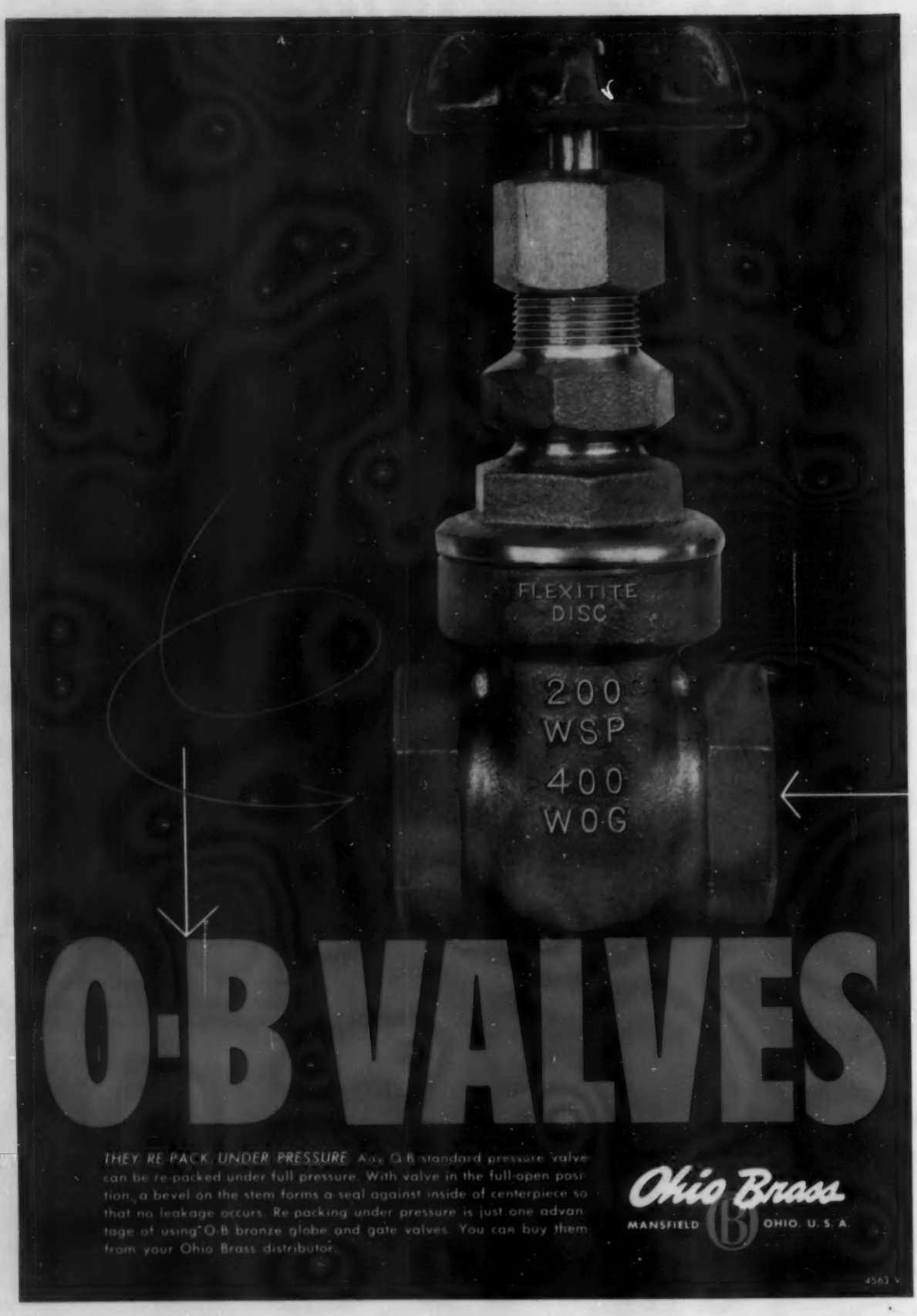

O-B VALVES

THEY RE-PACK UNDER PRESSURE Any O-B standard pressure valve can be re-packed under full pressure. With valve in the full-open position, a bevel on the stem forms a seal against inside of centerpiece so that no leakage occurs. Re-packing under pressure is just one advantage of using O-B bronze globe and gate valves. You can buy them from your Ohio Brass distributor.

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MANSFIELD OHIO, U. S. A.

4563 V

CRAWFORD small-parts dexterity test: measures fine eye—hand coordination

TIMING the applicant with stop watch is part of the testing procedure here

Today, aptitude tests help you select plant personnel,

says Dr Harold Seashore, The Psychological Corp, New York, N. Y.

EDITOR'S NOTE: Third in a series. See "Selecting Plant Personnel," Dec 1954, pp 125-127; "Selecting Maintenance Men," June 1955, pp 117-119. Look for more articles on the subject.

► THE OLD-FASHIONED HIRING OFFICE is obsolete in this highly mechanized age of automation. Reason: People handling the operation and maintenance of power services in industry are too expensive today. Too, it often costs more to get rid of the wrong guy than to hire the right one.

Fewer laborers—those who move, lift, turn things or push loads on barrows—are needed. Coal heavers and ashmen are about nonexistent. People who control switches and read dials, inspectors and machine adjusters, technical supervisors, operators of heavy equipment, and all kinds of fixers and trouble shooters now operate and maintain our complicated power plants and distribution facilities. This means higher-type men.

While a lot of industrial work is still repetitive and routine, today's employee must become specialists. Many of them have to make fairly detailed and prompt decisions. Because of this shift in duties, men work in a larger variety of more specific tasks than a generation ago.

Spotting comers. A bus company makes sure some of its unskilled entrants have aptitudes to provide the firm with mechanics, drivers, traffic managers, clerical help and other skilled workers. Trainees for these better jobs come from beginning workers, many of whom start by sweeping buses. A bus company's manning table must provide for replacements at all levels and all jobs from within its labor force. This

GROUP TESTING should be done in quiet place where applicants are not distracted or upset. They should be allowed to concentrate on the test placed before them

is a far cry from hiring people for particular slots that happen to be open on a given morning.

Your personnel department should be responsible for: (1) knowing talents and skills needed by your company or department now and years ahead, and (2) recruiting, selecting, training, placing and upgrading employes. Manpower planning is a major concern of management today. That means men responsible for personnel must do the job by using scientific ways that are better.

Personnel costs. Screening applicants is important. The cost of each failure, even at lower jobs, is very high. Selection process itself is costly, training is still more costly. Failure on the job may damage equipment and production and is also distasteful.

Interview techniques are better today. Methods of inducting new workers are improved. Better descriptions of jobs and requirements of people who fill them are stressed. Big push has been to upgrade the whole hiring process.

Making predictions is the personnel man's job. He says: "I predict this man will make good on that job." Or he may hedge and mean, "Among applicants available, I predict he will be best for the job open."

Your goal is to improve employe predictions. What increases the batting average of hiring office? How do you reduce failures, turnover and unrest? How will you secure the best among workers available? How do you improve chances of having a good bench of substitutes when jobs at higher levels become open?

Prediction about a worker is fairly easy when he's known for a long time. For example, a well-recommended machinist with ten years' experience should make a good employe. But suppose standards of his former employer are not those of the new firm? Suppose their "excellent man" in a new situation turns out to be a hack? Of course, the reverse may be true.

Usually the employment manager doesn't have good factual evidence of abilities and skills, especially if the applicant is young, or just out of school. So among applicants who seem qualified by education and reference he may want to select those with greatest long-time potential for growth.

Testing enters here. In a few minutes of testing, you can gage a man's level of mental ability fairly well—his special aptitudes and some skills he claims. This information costs little, helps you tag him for future growth. Your percentage of successful hires will go up. Of course, psychological testing won't solve all personnel problems. For instance, measuring motivation is still lacking.

Failure on the job may be from other than aptitude or skill; for example, supervisor may not like red-haired apprentices or there may be turmoil in a man's home. Also, we know more about testing for some jobs than others.

Case History. In 1950, American Gas Assn tried a battery of tests. These were used: (1) Wonderlic Personnel Test, which indicates mental ability by measuring intelligence. (2) Bennett Mechanical Comprehension Test, indicating knowledge of mechanical principles and operation of common machines and equipment. (3) Hand-Tool Dexterity Test for handling common wrenches and screwdrivers. These tests increased proportion of good employes over those hired without tests, Chart 1.

Predicting turnover cuts costs. A large steel company lost many general laborers soon after hiring. Men had been given several tests but were hired without regard to their scores. Findings in three plants showed that more men who scored high on mechanical comprehension test were still at work a month later than those who scored low, Chart 2. Now the company does not hire those scoring in lowest quarter.

Test-selected applicants at another steel company showed better survival-on-the-job. Men and women were selected for clerical jobs and junior and senior technical positions. Chart 3 shows how adding tests to regular screening procedures selects employes who survive probation.

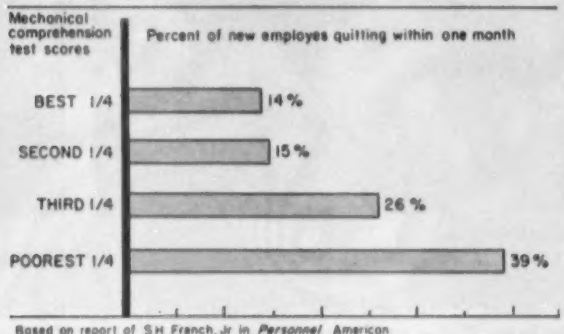
Tests are supplements, not substitutes, so don't discard your other well-established personnel procedures. You should still interview, use application blanks, check references, etc. Test scores help you screen out those who shouldn't be interviewed at length and give those passing the test hurdle more complete study for filling job.

BENNETT Hand-tool Dexterity Test measures use of wrenches, screwdrivers, bolts

1: Men best on tests were best on job

Tests used	Rating on the Job: Best third	Middle third	Poorest third
Mental ability	24 points	20 points	14 points
Mechanical comprehension	40 points	33 points	30 points
Hand-tool dexterity	343 seconds	396 seconds	398 seconds

2: Fewer high scorers quit than low



Based on report of S H French, Jr in *Personnel* American Management Association, March 1954

3: How combination of hiring procedures and aptitude tests improved selection

187 men and women were hired

125 were all-round acceptable candidates. This included being *above average* on selection tests

Of these 125: 90% survived probation
75% were promoted or received merit increases

62 were below average on tests but were otherwise acceptable

Of these 62: 36% survived probation
16% were promoted or received merit increases

Based on report of T H Wallace in *Journal of Business*, University of Chicago Press, January 1955

Beware. Great desire for objective methods often oversells idea that tests will improve your personnel predictions. You may not have experience of American Gas Assn. Some test makers and promoters are more interested in making an easy dollar than building a solid scientific foundation. Test specialists can only say that since tests have proved predictive in so many situations, it's likely their use will prove helpful to you.

Here's why I'm conservative. Companies differ in handling employes. Tests won't predict well where favoritism exists, where bright people are lost in the shuffle, where morale is bad. Because of shifts in labor market you may have to raise or lower your minimum hiring score, depending on labor supply. For some jobs, very high mental ability or other special aptitude may not be an advantage. A brilliant, mechanically inclined man may be a poor truck driver if kept on such work after the novelty has passed. He'll quit because he's not bettering himself.

Personality a factor. Two people of equal ability may perform quite differently on a job. Personality is one answer. Consider two men on machines needing fairly high ability, good judgment, fine hand skills and accurate measurement. One is highly successful, turning out 125% of normal production, while the other produces about 85%. Study shows the men are equally able on tests, differ in ways tests don't measure. Man A is steady, unworried, quiet and self-disciplined. Man B is in a dither most of the time, is socially inept, is butt of jokes.

Psychologists don't have tests to measure these personality traits well enough at present. Nor can employers specify exactly the personality needed for various jobs. You must rely on interview and work references for personality characteristics. These traits can be so disruptive that sometimes a man shouldn't be hired, or if hired should be handled in a special way on a given job by a selected supervisor.

What tests should power men include for screening applicants for jobs requiring less than a college education?

1. General ability. Trend is toward short tests, developed for the factory. Such tests are usually verbal. Understanding words is best index of mental ability needed to learn new things and deal with ideas. Five-minute Verbal Test of Personnel Tests for Industry (PTI) is a good example. Oral Directions Test, given by phonograph record or by tape, is improved way of testing.

(*Continued on page* 188)

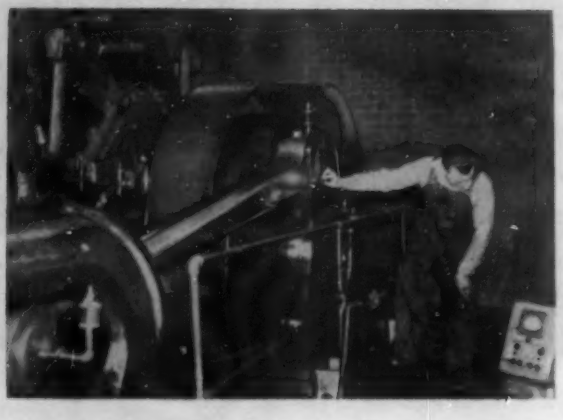
OPERATORS' NOTEBOOK 89

You can spot breakdowns

Some plant uses for this handy tool—the reflectoscope

Crankshaft may have flaws

Ultrasonic testing of this new diesel crankshaft shows up any hidden flaws. This is good insurance before placing new parts in machine. Here, old crank cracked through web. Operator is placing crystal (described on p 111) on crank web. Crystal projects a mechanical vibration or wave of extremely high frequency into the metal. Wave is projected through length of web, in path directly under the crystal, tests only segment of steel directly in its path. Keep moving crystal.



Crankpin tested in place

Here instrument is set up near machine, test made to find flaws in engine crankpin. If a defect is present, wave is reflected from it. If this defect happens to extend in a direction parallel to the wave, it presents practically no obstruction to the wave and won't be detected unless crystal is changed to new location. To detect such a defect, move crystal to another surface so wave travels at angle to defect, thus being partially or completely blocked in wave's path.

Flywheel shaft

Fatigue cracks in axles or shafts, which are hidden from view by flywheels, bearings or crank disks, show up distinctly under reflectoscope inspection. Besides, size and location of such cracks may be found. That helps operators to use the shaft as long as possible, yet alerts them to remove it from machine before failure from any defect growth.

Metal thickness

Lost metal is detected on location. Extent of both internal and external storage-tank corrosion is found without emptying—or entering tank. Pitting plates has same effect on sound waves as defects or cracks. Thickness of plates can also be measured with reflectoscope. You learn if plates have become dangerously thin with time. See Fig. 5, p 111.

Pipe for flaws

Critical-high-temperature, high-pressure pipe is inspected for dangerous defects. Here the angle search unit is used. Sound ricochets off inner and outer walls, circling the pipe until it returns to the search unit. Defects in the path of sound reflect back and appear as an intermediate signal on screen, which operator watches. See Fig. 1 to 4, p 111.

quickly before they happen

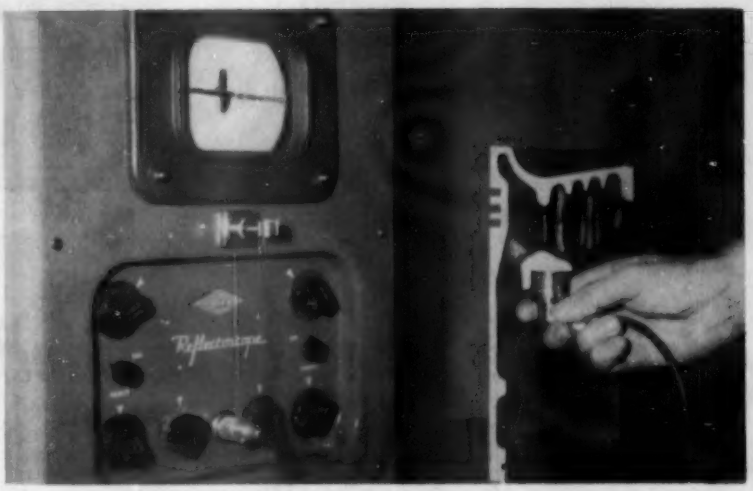
By STEVE ELONKA
Associate Editor

Here's how the reflectoscope works

► IF YOU CAN'T AFFORD costly breakdowns, answer is preventive maintenance. One way to prevent work stoppage is to "look" inside metal for flaws, replace such parts before they fail. Instrument coming into common use for this job is the reflectoscope. This is a portable electronic instrument producing pulses of ultrahigh sound. These pulses are induced into an object under test by a crystal search unit.

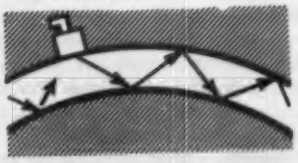
Nondestructive tests can be quickly made for fatigue cracks, internal flaws, corrosion, wear and imperfect welds. You not only don't have to drill or cut open part being tested (for loss of metal) but you often don't even have to remove part from machine, as these photos show. That saves time and costly labor.

Two beams. You can use two search beams: a straight beam and an angle beam. With a straight beam, sound waves travel straight through the object. They bounce off the opposite side, and are picked up again by the search unit. This gives you thickness measurements. This beam also detects any defects in the material that are in the wave's path, doing a twofold job.

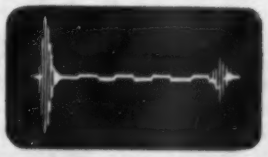


With an angle-beam search unit, sound waves don't bounce straight back to the search unit, but ricochet off all sides and through all areas of the object. This search unit is especially useful for checking welds, pipe and tubing—also, other objects where a straight unit might prove impractical or difficult. Instrument penetrates and indicates reflections through 30 ft of aluminum or steel. In porous metallic and nonmetallic materials, maximum penetration varies—depending on wave length to within fraction of an inch. *Courtesy, Sperry Products, Inc, Danbury, Conn.*

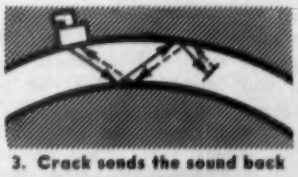
Let's test your pipe lines for flaws and thickness



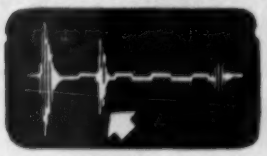
1. Sound bounces off inside walls



2. Flow shows on viewing screen



3. Crack sends the sound back

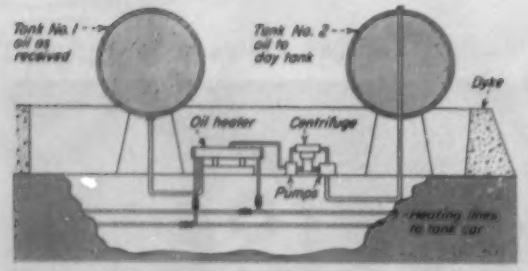


4. Screen shows crack like this

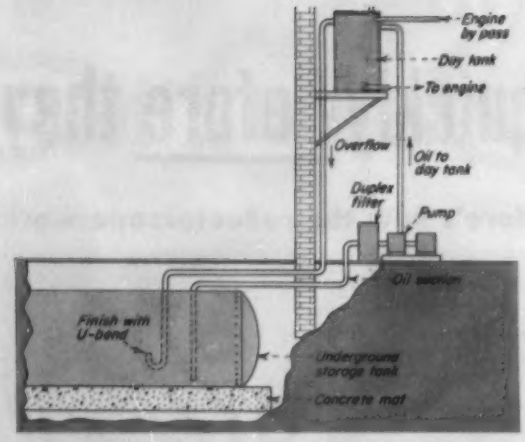
5. Thickness is measured here

Typical maintenance test is of high-pressure steam piping. Here sound is beamed into pipe wall at an angle with search unit. Sound ricochets off inner and outer pipe-wall boundaries in its travel around pipe, and returns to search unit, Fig. 1. Uninterrupted flow and beam's return are indicated on reviewing screen, Fig. 2. Any discontinuity in path of sound beam reflects a portion of energy back to search unit, Fig. 3. This shows on screen, Fig. 4.

Thickness measurement. Here the sound is beamed into pipe wall with a straight beam and reflects from inner face, Fig. 5. Length of time needed for sound to reach inner face and return to search unit varies with thickness of material. Thickness is indicated on screen. You can thus measure degree to which bent pipe (for example) thins on outside and thickens on inside of bend, assuring full specified thickness in high-pressure work. It has many other plant uses.



Two-tank system permits storing oil, as received, in one tank, then centrifuging before pumping to second tank



Day tank is installed in engine room. National Fire Protection Association standards limit maximum capacity

Here are some good ideas for storing

'You can save money if you know how to correct fuel-oil measurements to standard temperature,' says C Morgan Jones in this practical article on storage methods

► WHEN PLANNING to install diesel-fuel storage tanks, calculate the amount of fuel your engine will burn between deliveries, then provide storage for twice this amount.

An engine in harness all the time, except for scheduled overhauls, uses about four barrels of oil a year per horsepower regardless of size. So a 1000-hp engine needs 4000 barrels a year, or 168,000 gal (42 gal per barrel). That is 14,000 gal a month. With monthly fuel deliveries, storage capacity should be 28,000 gal in two tanks.

Delivery can be made in four ways: (1) tank wagon—200 to 4500 gals (2) tank car—6000 to 10,050 (3) oil barge (4) direct from pipeline or refinery.

The oil is sold and billed at 60 F. But it expands or contracts with temperature changes. Use temperature-correction charts to find out how much you should pay for. For example, if the tank contains 10,000 gal at 80 F you are actually getting only 9920 gal at 60 F.

When level in tank car is below the point where dome joins the shell, there is said to be an outage. If oil enters dome there is an inage. Tank-car capacity is stenciled on side or end, and you can get tables giving outages for all car sizes.

If your plant is in a city, local fire regulations may limit you to a 5-day supply. Some building codes demand that tanks inside buildings be separated from the rest of the structure by concrete walls. Other building codes state that outside tanks must be a "reasonable" distance from buildings. In one city, the distances range from 10 ft for tanks 500 to 1500 gal, up to 50 ft for tanks 20,000 gal and more.

Always put oil filters between pump and tanks. Remember, the bigger the pump, the bigger the filter. Use the duplex type so filter can be cleaned without stopping fuel flow.

Metering a delivery offers no problem. But it's advisable to put an air eliminator or gas trap in the line to prevent vapor affecting the metering. You can also incorporate temperature compensators in the meter.

Sometimes there is a meter between storage tank and day tank, but overflow returns to the storage tank. This is not a good practice as oil returned to the tank has passed through the meter and is charged against the day tank. It's better to use a shutoff device that works automatically when tank is full.

A good place for the day meter is between day tank and engine. Then taking frequent readings is easy.

Storage. If you use the 2-tank system, you can clean one tank while the other supplies the plant, without interfering with operation. Another advantage: If oil has high water or sediment content, you can store it in one tank, centrifuge, and pass it on to the second, where it stays until pumped to the day tank.

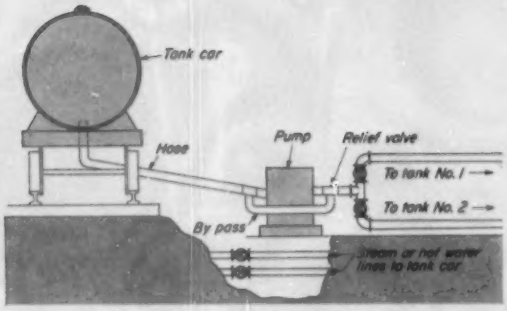
Of course, in some districts laws limit the amount of oil you can store in any one place. Then you need more frequent shipments to maintain sufficient reserve. Again, if shipments must travel long distances, it is sometimes cheaper to buy in larger quantities if you get reduced transportation prices.

Tanks can be horizontal or vertical, and made to any size. Check with your insurance underwriters as to whether they should be buried or above ground.

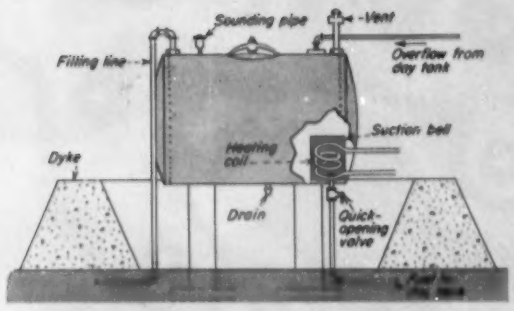
Storage tanks are "strapped" to help you get an accurate measurement of the contents. That is, they are measured by a definite formula. These measurements, supplied by the tank builder, are a reliable check on fuel use.

Unloading. After deciding on tank capacity, consider methods of unloading. If tanks are below the level of railway siding or roadbed, fuel will run out. If not, oil must be pumped. Any rotary, centrifugal or plunger pump will do if it has the capacity.

Railroad tank cars must usually be unloaded within 48 hours. To avoid paying demurrage, install a pump with ample capacity. Be sure you can make steam or hot-water hookups to avoid winter pumping troubles when jelled oil must be heated. Tank cars are fitted with coils for this purpose. So install pipelines to exhaust-line water-heaters or waste-heat boilers.

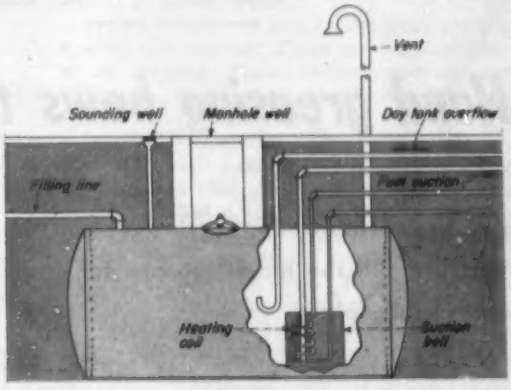


Tank-car unloading is easy with this hookup. The steam or hot-water lines help avoid winter pumping troubles



Aboveground tanks are usually prohibited in congested business districts, in residential areas and near streams

diesel fuel oil



Underground tanks should be set on firm foundations and surrounded with soft earth or sand, well tamped in place

Heating and cleaning. When oil is in storage tanks, the next thing is to get it out. Use a transfer pump, or, if plant is very small, a hand pump.

Light oils, less than 150 ssu at 100 F, rarely need heating or cleaning. Regular engine strainers and filters take care of any entrained dirt. But suction lines must not go to the bottom of the tank. They should stop two to five inches above the bottom.

Heavier oils are often dirtier, and require heating to pump in cold weather. Of course, if you specify a low pour point, this may not be necessary. But this specification can jump the fuel cost, and heating may be cheaper.

The heat required to make most oils run freely is small. For example, an oil of about 500 seu is not easy to handle at 100 F. But if you increase the temperature to 130 F, it thins down to about 200 ssu. This doesn't take much heat.

If you don't have a waste-heat boiler and exhaust jacketing is not possible, use a small diesel-fuel-burning boiler. You can also circulate hot water from engine cooling-water jackets through heating coils, but if a fracture ever develops in the oil tanks you may have an engine failure. So make all heating tubes in tanks seamless with welded joints—don't use flanged or screwed joints. If you use this system, cut into the discharge line from engine to cooling tower.

If any engine runs on heavy oil, it's good insurance to start and stop on a light one. Light oil capacity can be small if starts and stops are infrequent. Install a 3-way valve to connect and disconnect the tanks as engine conditions demand. This keeps both tanks from supplying the engine at the same time.

Always follow above plan for starting and stopping when fuel has a high sulfur content. It prevents engine corrosion during shutdown periods.

Impurities in oils of more than 150 ssu do not settle out readily. If analysis shows more than 0.008% sediment, centrifuge the oil. This should cut sediment by half, at least.

Heat the oil to be cleaned to 200 F, providing this temperature is not near the flash point. It is better to use coils for heating. They should be big enough to encircle the suction pipe, and never more than 18 in. in diameter. When burning the lowest grades of fuel, you may have to steam-jacket the suction line for its entire length.

Don't use rod-type electrical heaters for this work. They localize the heating. It's better to use them for heating water or steam for the coils.

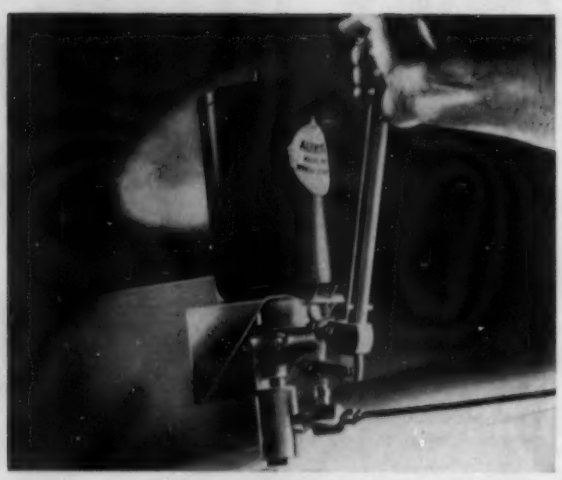
Cleaning the tank. Before sending a man into a tank for cleaning or repair, flood it with water. After pumping out water, ventilate tank with blower or wind sail, or blow live steam through it.

To be on the safe side, have a second person stand by at the manhole opening when anyone is working inside, however clear of fumes tank seems to be.

It's simple to clean tanks for storing the lighter fuels. Drain tank with hand or power pump whose suction point is within a half inch or so of the tank bottom (sludge permitting). Or use the drain if tank is above ground. You can put the pump suction tube inside the vent or sounding line if service suction line isn't to be disturbed. Then use wire brushes to remove rust.

When cleaning tanks used to hold heavy oils like bunker C, the long job of steaming and hand scraping is the surest. Often it is also the quickest.

Check suction line when cleaning tank. If it's corroded at the end, replace with a steel one. Don't use galvanized pipes in storage tanks. Test heating coils by immersing in a barrel of water, plugging one end and forcing compressed air into the coil.



Hand greasing bows to central schemes...

Plant safety, better lubrication and sizable dollar savings are still the major reasons for adopting central lube plans

► THERE IS LITTLE basically new about centralized lubrication. For years, lubrication-system manufacturers have pointed out the gains to be had by swinging from hand oiling or greasing to one of the many central lube schemes.

Yet at this year's annual meeting of the American Society of Lubrication Engineers in Chicago, the benefits from central systems were aired again, but this time with strong emphasis on the dollar-saving and safety angle. With the discussion swinging from bald economics to safety, several speakers from industry painted a clear picture of what every engineer knows in his heart, yet often fails to sell to management: *There's big money being wasted in sending a man traipsing about the plant with an oil can.*

At this same meeting, engineers from the Wheeling Steel Corp stressed the role played by central systems in plant safety. Point was well made that many of the serious accidents in the Steubenville Works were traced directly to hand-lubrication methods. To correct this, at least in part, Steubenville is now swinging over to central lube systems on their overhead cranes.

Philosophy of centralized lubrication hasn't changed through the years: Better lubrication through delivery of precise quantity of lubricant at the proper time. Safety engineers still spot the lowly oiler's job as one of the plant's most hazardous. Where old hand-lubrication methods are in force, there are many bearings that require personal

Grease thinning and flowing out of bearings?

► "CAN I MIX two greases in service without getting into trouble?" That query pops up every so often. And it got a straightforward answer at this year's annual meeting of the American Society of Lubrication Engineers. Lab performance tests now back up field checks: mixing two or more greases with different bases can seriously affect resultant grease qualities.

Incompatibility of grease mixtures may come to light in several ways. But evidence of grease incompatibility is generally excessive fluidity soon after mixing. Several examples were outlined by A L McClellan and S R Calish Jr, of the California Research Corp, in a paper presented before the ASLE. Simplest case involved automotive wheel bearings. After a routine check on a new car, service-station attendant spread a different grease over the original and in short order a soft-grease mixture streaked outside the front wheels. Check on the resulting mixture showed both calcium and sodium soaps present.

Mixing a lithium-calcium-base multipurpose grease with a barium-soap product in the rolling-contact thrust bearing of a ball crusher pointed up another instance of incompatibility. Here it just wasn't practical, at the time, to thoroughly clean the bearing when changing lubricants. Grease mixture operated satisfactorily for a spell, then finally flowed out onto the floor. Consistency of resulting soft grease had no resemblance to original products.

Another case involved a cannery when greases of different soap bases were tried one after another to lick a lubrication problem. First a calcium-soap grease was used. Time showed its heat-resistant properties fell short for the particular application. Next, a

Recorder keeps check on lube

Some power men use a 24-hour recorder tied into their central lube system as a performance-log and trouble-shooting instrument. This setup requires hooking recorder into a pressure-switch in lube feeder circuit.

Example: When automatic system is adjusted for a definite cycle, recorder checks if timing runs above or below the set bearing-feeding period. If chart shows cycle is delayed, trouble may be air pumped into the lines after reservoir runs dry. A leak or a worn pump may be causing the trouble. But at least you get a warning. However, in modern well-engineered systems failure is rare.

. . . but slowly

attention at least once each shift. This means the oiler must climb ladders or machine frames, often with unit operating, to turn a grease cup or direct a squirt of oil.

Centralized lubrication changes this picture by making the job fully automatic or at least reducing lubrication of a complete machine to a few strokes of a hand-operated central dispenser, *photo facing page*.

Most lube engineers agree that selling a central system topside involves a 4-point program: *safety, better lubrication, reduced manhours, fewer lubricants.* In selling management, bear in mind that years back men who operated machines were often skilled mechanics who lubricated and maintained their own units. They may not have been lubrication experts but they did have a single-minded interest in keeping them going.

But as industry became larger and more specialized, maintenance tended to separate from operation. And, unfortunately, lubrication too often drifted off into an independent chore that got little real attention from anybody. "Oiling" became a low-skill low-pay job with little incentive. Today, lubrication engineers have stepped into the picture. They're making lubrication an organized, scientific plant function with central lube schemes as but one of their tools.

As a case in point, consider a bearing in service that measures 3 in. in diameter and has a lube capacity of 0.058 oz. The 3-in. shaft spinning at 500 rpm revolves 240,000 times in eight hours and travels the equivalent of 35.7 miles between oilings, assuming lube is applied every 8 hours. If a single feeding is missed, shaft travels more than 70 miles between oilings.

Now if the same bearing is centrally lubricated every 15 minutes, it makes only 7500 revolutions or 1.1 miles between feedings. And time between can be adjusted to insure a clean, adequate lubricant film on bearing surfaces at all times. As operating conditions vary, both the amount of lubricant and timing can be regulated as needed. And there will be no missed feedings.

System components of a central setup are grouped about a pump and reservoir. Pump may be manually, electrically or air operated. Piping connects reservoir and points of application. Systems operate with either oil or grease, grease being the most popular.

Installation. Once the management hurdle is past, follow a carefully worked out plan when installing a central scheme on production machines. For instance, if you're planning to install a central system on all existing machines, it stands to reason you can't shut down your plant for months to do the job. So the first step is to take one machine and fit it with circuit metering valves. Then connect metering valve on each bearing to pumping system.

Alternate plan may be to locate metering valves in groups of two or five at some convenient spot on machine. Select this spot so it can be readily reached for future maintenance. Then run lines from each metering valve to its bearing.

It may be wise to use a hand-operated pump on each machine until entire group of machines can be hooked to an automatic supply unit. Then the operator, with a few strokes of the pump handle, can cycle the lube system in a short time while machine is operating.

After basic circuits and metering valves are installed on all machines in the zone, replace hand-operated pump with an air- or motor-driven pump to supply lubricant automatically to all machines in that zone.

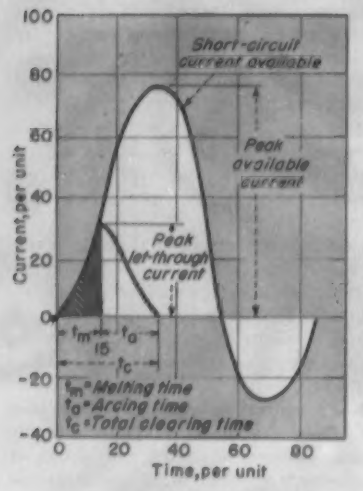
Might be you're mixing incompatible greases

sodium-soap grease was tried. This worked well till the night crew hosed down machinery, washing grease out of exposed bearings. Finally, a lithium-base grease was tried. In time, a fluid grease flowed from critical bearings. This fluid mixture contained almost equal proportions of calcium, sodium and lithium greases. After proper cleaning of bearings, the lithium-soap grease provided excellent lubrication.

Steel mill proved still another testing ground for illustrating grease incompatibility. While service-testing a new extreme-pressure steel-mill grease, test lube was introduced into the distribution-system pump after flushing out main distribution lines. Where this lithium-calcium product mixed with grease already in the smaller distribution lines and bearings, resulting mixture lost all semblance of grease structure and was fluid even at room temperatures. This fluid mixture contained lead, sodium and aluminum plus lithium and calcium. Further checking showed previous mixing had occurred because of an oiler's mistake. He mixed a calcium-lead-base grease with the sodium-aluminum grease ordinarily used.

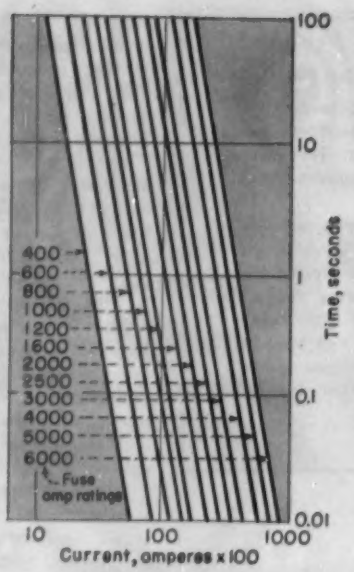
This boils down to the bare fact that grease-mixing in the field can often lead to trouble; that is, mixing greases of different bases. Physical mixing of some greases in the lab shows a change in dropping point, greatly accentuated by heat. Performance tests, in the lab, show further that instability is often associated with some grease mixtures.

Here's your practical operating rule: Steer clear of many plant-lube headaches by separating different grease types. Where a knotty problem involving grease mixing crops up, call in your lubricant supplier for his thinking.



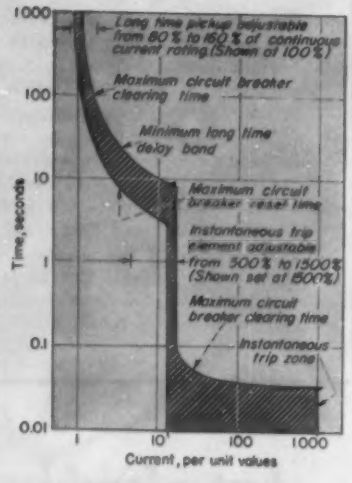
Current-limiting action

Fuse is current-limiting when element melts before current reaches maximum available value. On melting, element vaporizes, developing high resistance, which in turn reduces current to zero



Time-current values

Melting time-current characteristic, above, for typical current-limiting fuses. Currents are rms amp flowing in circuit. For high available amp, current limited at less than ½ cycle


Long time pickup adjustable from 80% to 160% of continuous current rating (Shown at 100%)
Maximum circuit breaker clearing time
Minimum long time delay band
Maximum circuit breaker reset time
Instantaneous trip element adjustable from 300% to 1500% (Shown set at 800%)
Maximum circuit breaker clearing time
Instantaneous trip zone
Time, seconds
Current, per unit values

Circuit-breaker trip band

Low-voltage breakers have dual over-current trips. Three time bands (minimum, intermediate, maximum) available for overload current trip. Fault amp handled by instantaneous device

How to back up low-voltage circuit

With available short-circuit currents zooming, silver-sand fuses in series with air breakers can be a dollar-saver. Here's how to tackle problem, yet stay out of trouble

► THIS BUSINESS of backing up a circuit breaker with a current-limiting fuse is not as simple as it sounds. When a current-limiting high-interrupting capacity fuse is considered for series hookup with a circuit breaker, it's generally because the available short-circuit current exceeds the breaker's interrupting capacity. And in such a setup, fuse must limit fault current to a value that will not damage breaker. At the same time, to avoid unnecessary fuse replacements, fuse should not blow on fault currents that fall within breaker's interrupting capacity.

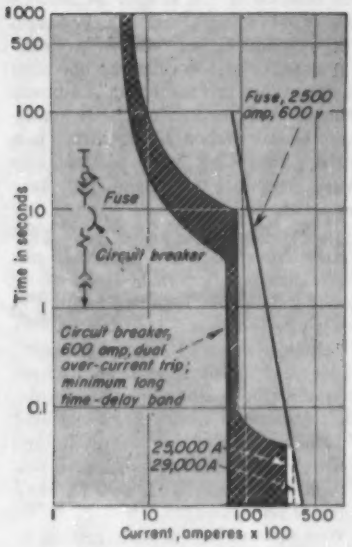
Coordination of the whole electrical-distribution system must be considered—right from the incoming high side of transformers to the final point of utilization. Before jumping to the fuse-breaker combination plan, consider your service-continuity needs. Some processes just can't stand a power loss for any length of time.

Current-limiting fuses are so-called because the fuse element melts before the fault current reaches its maximum available value. On blowing, the fuse element vaporizes, becoming an arc with high resistance. Fault current is, therefore, brought down to zero, sketch, top left.

Note from sketch that melting time for a true current-limiting fuse is substantially less than the first half-cycle of fault current. Fuse melting-time depends on heat generated at every instant and is proportional to current squared at each instant. Time in which a fuse melts depends on rate of current rise during melting period. A faster rising current melts fuse sooner and at a higher instantaneous-current value. Actually, the time needed for fault current to drop to zero after reaching its peak is affected by circuit voltage, value of peak, fuse characteristics. Tests show this value is about 1.5 to 3 times greater than time taken to reach peak value.

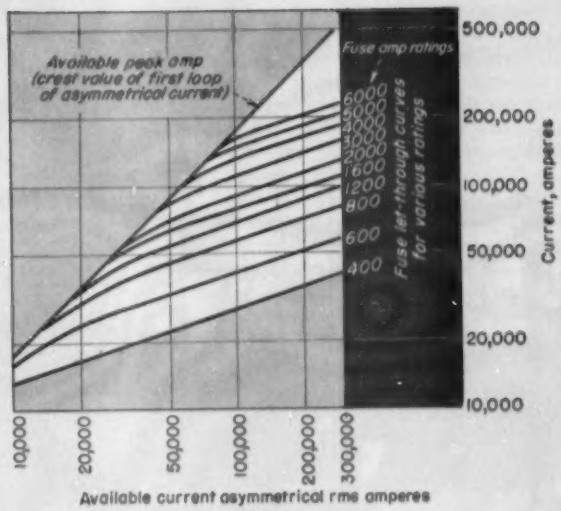
Air circuit breakers have an interrupting rating in amperes. This rating is the average rms value of fault currents in the 3 phases, measured a half cycle after fault occurs. Low-voltage air breakers have direct-acting over-current trips. These devices are equipped with two elements: one takes care of short-time overloads, while the other handles fault currents. The long-time overload device is adjustable from 80 to 160% of breaker rating. Three time bands—minimum, intermediate and maximum—are provided to give

EDITOR'S NOTE: For more background information on high-interrupting current-limiting fuses, see *Power*, Oct 1953, pp 107-108. Above article is a free adaptation of a paper by M S Carlson and A Conangla, I-T-E Co, presented before AIEE Conference on Electrical Applications in Textile Industry, Atlanta, March 1955.



Matching breaker and fuse

Using time-current characteristics of fuse and breaker, you can select fuse whose melting time curve crosses breaker instantaneous curve at point equal to breaker's interrupting rating



Let-through current, typical current-limiting fuse

Here the available fully displaced rms amperes of one phase are plotted against the instantaneous peak let-through amperes for high-interrupting capacity fuses of different ampere ratings. High ampere-rated fuses require extremely large values of available fault current for true current-limiting action

breakers with current-limiting fuses

better selection in the over-all coordination problem. The short-time or instantaneous trip can be adjusted for 5 to 15 times the breaker rating. This combination of elements is a dual-magnetic overcurrent trip device. Typical minimum trip band is shown above, left.

Heat developed in a breaker is proportional to the current squared. Mechanical forces on breaker parts are proportional to square of the instantaneous current values.

All the above boils down to the fact that to coordinate current-limiting fuses and air circuit breakers, the time-current characteristic (sketch, top left), peak let-through amperes and instantaneous current-squared values must be considered. How are these characteristics used to get a coordinated system? Keep in mind that in a fuse-breaker coordination, we are primarily interested in the fault-current range.

Time-current characteristics make possible selecting a fuse whose melting-time curve crosses the breaker instantaneous curve at a current value equal to the breaker's interrupting rating. A fuse so selected permits the breaker to do a job to the limit of its capacity without the fuse blowing. Yet the fuse will melt on currents above breaker's interrupting capacity without damaging breaker. *The take-over point should be 18% above the breaker's interrupting rating.*

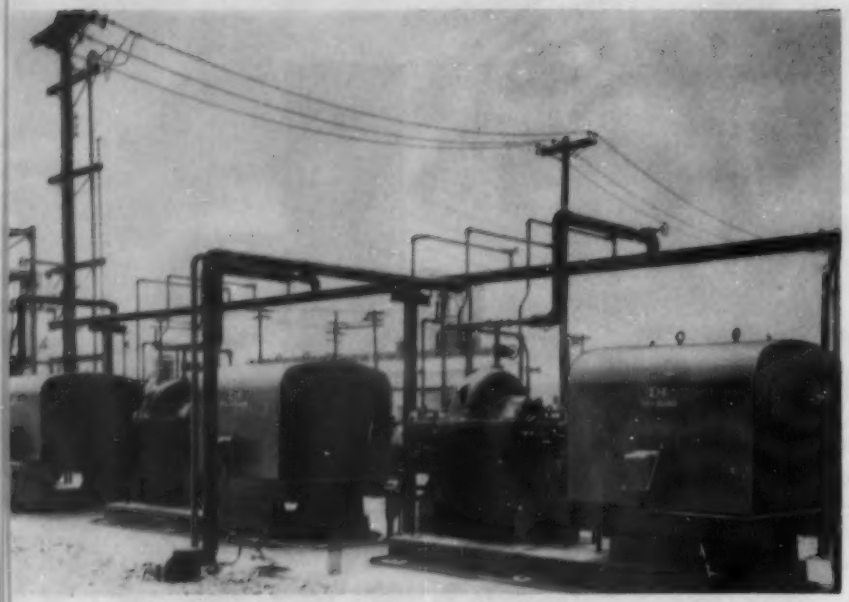
However, the above method fails to determine the peak let-through amperes. This value can be checked from curves, typical, top right. If let-through current exceeds breaker's momentary rating, check another fuse value.

Peak let-through current characteristics could be used for fuse selection. Here the peak-let-through should not be greater than twice the breaker's interrupting rating. When selecting a fuse in this manner, its melting characteristics would be plotted against the breaker time-current curve. Actually, this method is quicker since it immediately takes into account the breaker's momentary rating limit. Both the time-current and peak let-through methods are complimentary to each other.

Current-squared values, as a basis for combining a fuse and breaker, are not yet too practical. Reason: Values for fuses are well-established, but not so for large circuit breakers. The actual current-squared values for large air breakers involve not only the breakers of five different interrupting ratings, but also continuous current ratings ranging from 15 to 6000 amp. Calculations can be made, but actual testing of numerous combinations is the only real answer. As of now, such tests have not been completed.

Application of a current-limiting fuse to existing feeder circuit breakers can provide the needed interrupting capacity. A fuse-breaker combination can be used in a panelboard to protect the main circuit breaker, ahead of a circuit breaker feeding a single load, ahead of the main breaker in a switch-gear assembly having no other source of power.

A final thought: All the points mentioned above in connection with large air circuit breakers are applicable to molded case breakers. In the latter category five frame sizes are involved with continuous ratings of 15 to 600 amp.



WEATHER-PROTECTED silicone-treated motors, above, are exposed to Gulf storms and salt air. Armature coils, insulated with silicone rubber, tapes and varnishes

Tomorrow's maintenance headaches will be trimmed because today's electrical manufacturers have let . . .

Silicones step in to stretch motor life

► MOTOR INSULATION and enclosures have seen major changes in recent years (POWER, June 1955, p 73). And in the past few months, motor manufacturers have announced several developments involving the silicones in winding insulation, motor enclosures, or both.

In mid-June, Electric Machinery Mfg Co announced that five 450-hp *Sil-Clad* motors had been placed in operation, driving centrifugal pumps in a large Gulf Coast chemical plant. All equipment is installed in the open, subject to Gulf storms and salt air. But these weather-protected motors have silicone-treated enclosures plus silicone insulations. Armature coils are insulated with silicone rubbers, tapes, varnishes. Metal surfaces inside and out are protected by baked-on silicone finishes. Screens, fans, baffles, in the vent air streams, are of stainless steel.

Metal parts of motors are protected with several layers of high-gloss silicone resin-enamel or resin. Baking at 400 F polymerizes the silicones into a tough plastic coating. Result is a literal envelope of silicone protection that shields motor structure from all the elements within silicones' resistive powers.

All-silicone-rubber insulation for their large motors and generators is now being supplied by Allis-Chalmers Mfg Co. Called *Silco-Flex* this new insulation boasts flexibility and resilience, moisture and abrasion resistance, homogeneity. Insulation is available for all Class H form-wound coils and for Class A and B windings operating under specific service conditions.

The silicone rubber is applied to entire coil structure, then vulcanized to form a homogeneous void-free dielectric barrier. In that way, built-up layers of dissimilar materials and binders are eliminated. A sample of silicone rubber, 0.074 mils thick, was aged eight weeks at 250 C, yet retained a dielectric strength of 500 volts per mil after flexing. Since this insulation is a homogeneous void-free barrier, the manufacturer claims carbon black, metal particles, cement and other contaminants cannot penetrate the windings to cause premature failure. Price is on a par with previous Class H.

All-silicone insulation may influence application practices in both the utility and industrial fields. For example, in power-plant induced-draft-fan motors the abrasive effect of atmosphere-borne cinder and flyash is claimed to have little effect on a silicone-rubber insulation. Motors in cement, ore crushing and similar installations will retain high overload capacities despite reduced ventilation that results from dust build-up in motor vent passages.

Wire-enamel insulation is getting its share of advantages offered by the silicones. Most recent development in this field came from the spanking new research labs of Westinghouse Electric Corp in East Pittsburgh when Dr Jack Swiss announced an insulation enamel tagged simply as No. 1267. Swiss, manager of insulation research at the labs, describes the new enamel as a modified polyester-type resin containing about 20% silicone. Inclusion of the silicones results in an enamel that withstands much higher temperatures and for longer periods.

Lab tests on electric motors insulated with 1267 show they can operate continuously for 10 years at a temperature of 163 C without damaging insulation. "Using this new enamel to replace the glass insulation normally required for high-temperature motor windings would reduce insulation thickness by 50%," Dr Swiss said. "This means we could make a standard motor of, say, 7½ hp no larger in size than the average 5-hp motor of today."

As yet an enamel coating alone cannot be classified as Class B under existing standards. But steps are being taken to change this. During the AIEE summer meeting in Swampscott, Mass., a committee action was taken, adopting the theme of accepting suitable enamels for Class B—criterion to be performance rather than makeup of specific materials. There is wide agreement amongst motor makers on the need for this change. Next step is acceptance by the AIEE Standards Committee.

In line with this step, toward making enamels suitable for Class B, is the acceptance of General Electric's *Alkanex* (a polyester enamel) by the Underwriters Laboratories for use as a motor insulation at Class B temperatures.

These simple pointers on adding water cut battery headaches

► First rule when watering batteries is make sure water is reasonably free of harmful impurities. Distilled water is best. In some sections the public water supply is OK too. If public water is to be used, test it first. Following are maximum impurities that can be tolerated:

	Ppm	%
Total solids	350	0.0350
Chlorine	25	0.0025
Iron	5	0.0005
Nitrates, nitrites	5	0.0005
Manganese	1	0.0001

Remember, impurities accumulate since water evaporation leaves solids behind. Fluorine, in the amounts normally added to the public-water supply to reduce tooth decay, is not harmful to batteries.

Water level must be carefully checked if you want maximum battery life. Most stationary batteries have maximum and minimum water marks; hold water level within these limits. If water level is allowed to remain below low mark, plates will dry out and become sulfated. Battery capacity is reduced since plate area is cut. If filling marks are not present, keep electrolyte level above plates.

Too-high-water level means a dilute electrolyte, lower specific gravity and decrease in battery capacity. And electrolyte spilling over battery top is a hazard.

Add water before battery gets its periodic booster charge, not after. Charging helps mix water with electrolyte, giving a uniform true sp-gr reading. Latter is important since it is used to indicate whether the battery cells are charged.

When adding battery water, consider using a glass container suspended high enough by a support frame so the water flows by gravity into each cell. Equip the container's rubber tube with a pinch-off device to stop flow when correct level is reached. Place entire rig on wheels so it can be moved from cell to cell.

Simple glass pitchers are often used for adding water although plastic, rubber or earthenware utensils may be adopted. Be sure they are clean and have a good pouring lip. Do not use a metal container since it may contaminate water. Some plants have adopted a rubber syringe for accurate controlled filling. Water to fill syringe is taken from a container, which should, of course, be of glass, plastic, rubber or earthenware . . . and it must be clean.

Don't fill battery cells with a hose that connects through a faucet to public-water-supply system. Even if water is approved for battery use, minor accumulations of rust in pipes may suddenly break loose and be carried into cells. Also, it is more difficult to regulate water flow, increasing danger of over-filling and splashing electrolyte. Fill a clean glass container with tap water if latter is approved. Then let it stand. All settled solids should be filtered out. Mark the container "For battery use only."

Adjusting sp gr of a cell, if some electrolyte has been lost through leaks, spills, overflowing, is tricky business. Here are some general tips. Sulfuric acid as usually sold is either 1.835 or 1.400 sp-gr concentration for storage battery use. To change sp gr to another value, acid must be mixed with water. When mixing, always add acid to water—not water to acid. Add acid in small amounts, mixing constantly. Heat usually develops when stirring acid into water. Cool mixture to 100 F or below before adding to the cell. Pouring a hot mixture into a cell may injure it.

—K A Vaughan, *Gould-National Batteries, Inc*

Steve Elonka cops award

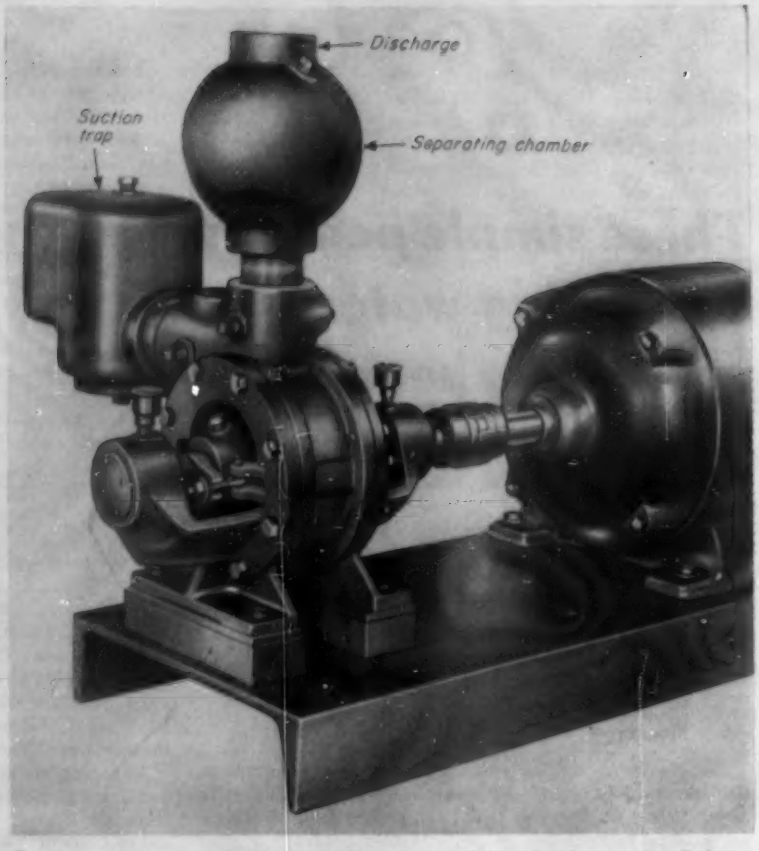
► Power's practical manual *Gaskets*, March 1954, not only rang the bell with readers, but Associate Editor Steve Elonka won an award to boot. Steve won a Jesse H Neal Achievement Award, sponsored by the Associated Business Publications. Award was presented at ABP's annual conference at Hot Springs, Ark. Judging committee was headed by Dean Kenneth E Olson, Medill School of Journalism, Northwestern U.

Gaskets is but part of the story on sealing started by Steve, with *Mechanical Seals* slated for 1956. *Mechanical Packing* was published in Power, March of this year. Both *Gaskets* and *Mechanical Packing* have been put back on the press for a second run. The way readers are ordering, they promise to be a big seller for some time to come. Reprint orders are one very practical way to measure reader interest in any subject: They're a good guide for editors.

PUMPS

E L ABRAMSON, *Chief Engineer*
Turbine Pump Department
Aurora Pump Division
New York Air Brake Company

By selecting and installing turbine pumps correctly you can often find an easy solution to the problems of handling a wide range of hot and volatile liquids in process plants. Here's how it's done



1 A suction trap on its intake and an air-separating chamber on its discharge help turbine pumps to handle air and vapor in liquid and also to be self-priming

The turbine-type pump is a natural

► OF THE PROCESS INDUSTRIES, none uses so many pumps for so many applications as petroleum refining. Every type has some application. Turbine pumps are commonly used for pumping condensate, hot oil, coolants, caustic solutions, doctor solutions, alcohols, naphtha, benzine, brine, sulfuric acid, hydrochloric acid, lube oil, distillates, kerosene, gasoline, aqueous ammonia, sodium carbonate, butane, isobutane, pentane, propane, hexane and many other liquids. These are either used in the refining process, or are the product of the refining process. These applications also indicate how turbine pumps may be put to work in other industries.

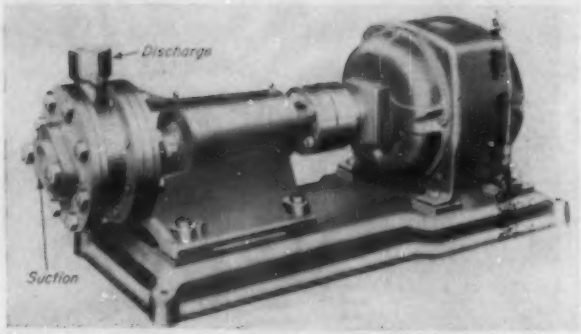
Transfer pumps. In refining, petroleum liquids must be transferred from one process to the next, or the final product put into tanks for storage until it is shipped. Turbine pumps are suited for these services because of their small size, wide operating range and high-pressure characteristic.

Fig. 2 shows a general-purpose pump often used as a transfer unit in refineries and bulk stations because of its rugged construction and easy installation. For most of these applications, standard bronze-fitted or all-iron pumps are satisfactory, but for corrosive liquids the pump end is usually made of special alloys.

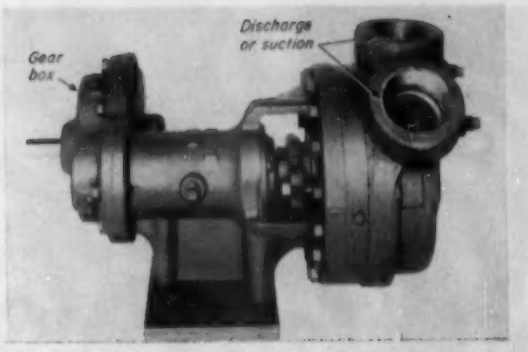
Hot-oil pumps. One of the most difficult pump applications in petroleum refining is handling hot oil for the charging process. These pumps must be of rugged construction, with large shafts, extra-deep stuffing boxes, and means for cooling the shaft, packing and bearings. Fig. 4 shows a turbine pump with water-jacketed stuffing boxes. Units of this type are designed for hot-oil service, or for pumping water at temperatures above 300 F. Also, these pumps are steam-turbine driven.

LPG pumps. The letters *LPG* indicate liquefied-petroleum gas, which is the most difficult of all the products of petroleum distillation to handle because of its high volatility. For example, propane, which is one of the most volatile, is a gas at atmospheric pressure and at all temperatures down to minus 51 F. To maintain it as a liquid to be handled by pumps, it is kept under pressure when stored or transported.

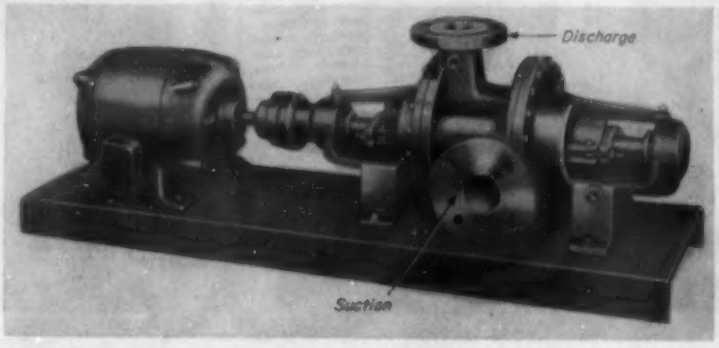
Other gases of the same type are butane, isobutane, a mixture of the two, or a mixture of propane with either of these gases. Propane stored in a tank exposed to the weather all the year round is under 149 psi in a summer temperature of 90 F, and 23.5 psi in winter at 0 F. This indicates why certain characteristics and special design features are required by pumps handling liquefied-petroleum gases, or other



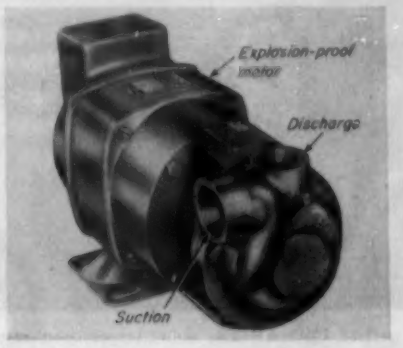
2 General-purpose motor-driven turbine pump of rugged build is often used as transfer unit in oil refineries, bulk stations



3 Specially designed turbine pump to handle liquefied petroleum gases when driven by power takeoff on truck



4 This motor-driven 2-stage turbine pump with extra-deep stuffing boxes has both the packing and shaft cooled by a water jacket at each end of the pump



5 Close-coupled turbine pump driven by explosionproof motor for hazardous spots

for handling your process liquids

liquids such as ammonia and Freon, which possess similar properties.

These characteristics and design features are: (1) Handle vapor with the liquid. (2) Develop high heads. (3) Have a wide operating range. (4) Have large suction openings to keep velocity of liquids entering the pump suction below 3 ft per second. (5) Have extra-deep stuffing boxes.

The first three requirements are inherent in turbine pumps and the last two are features built into them. Mechanical seals replace stuffing boxes on many applications where liquefied petroleum gases or refrigerants are handled, as they prevent all leakage around the shaft. Specifications of most refineries and chemical plants call for mechanical seals in pumps for the services described.

Other turbine pumps. Fig. 5 shows a close-coupled turbine pump for handling liquefied petroleum gases or other volatile liquids of a similar nature. Because liquefied petroleum gases are flammable, electric motors and switches used with the pump must be of explosion-proof construction.

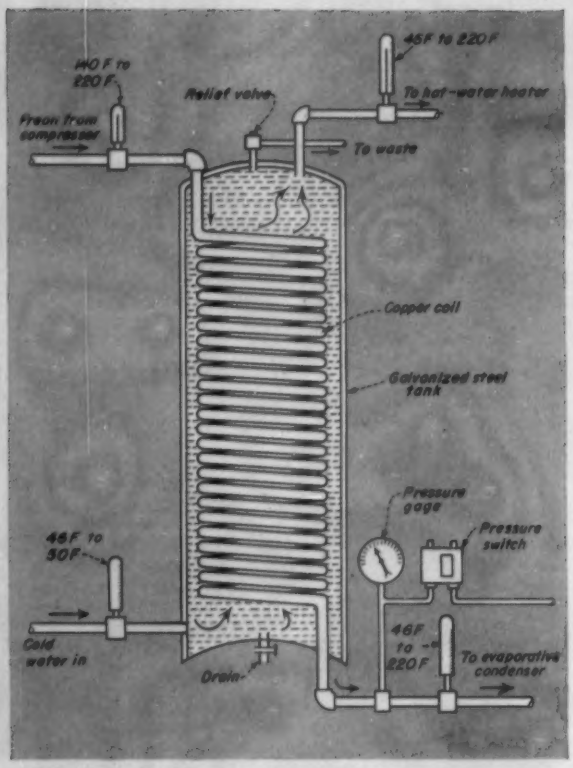
Large tank trucks for transporting liquefied petroleum gases usually have their own pumps mounted underneath their chassis and driven from a power takeoff. Fig. 3 shows a special design of turbine pump for truck mounting. This assembly has a 3 to 1 speedup

(*Continued on page* 194)

Suction-pipe size for best turbine-pump operation

Capacity, gpm	Recommended pipe size, in.	Velocity, ft per sec	Capacity, gpm	Recommended pipe size, in.	Velocity, ft per sec
5	1¼	1.07	40	2½	2.68
10	1¼	2.15	45	3	1.95
15	1½	2.36	50	3	2.17
20	2	1.91	60	3	2.60
25	2	2.39	70	3½	2.27
30	2	2.87	75	3½	2.33
35	2½	2.35	100	4	2.52

HEAT EXCHANGER, *right*, serves as a condenser for 7.5-ton Freon compressor, heats hot water for all services in plant



CROSS SECTION through heat exchanger, showing tank, coil, water inlet and outlet, drain and the pressure-relief valve

Are your fuel and water costs higher than you like? Do power bills make you squirm? Then don't miss this chance to learn how a . . .

Smart refrigeration hookup slashes plant water-heating costs

By PAUL M STURGES, *Industrial Consultant*

► Two of the biggest problems facing many plant engineers today are (1) how can we reduce cooling-water consumption, and (2) how can we reduce fuel costs? If your plant has refrigerating equipment and need for hot water, you may be missing a bet on solving both these problems easily. Let's see how one plant did.

Heat source. Every refrigeration unit rejects heat to its condenser during condensation of the hot gas to a liquid. With watercooled condensers, the condensing water is discharged to the sewer or to a cooling tower, wasting whatever heat was picked up in the condenser. Where water is plentiful, discharge to the sewer is often the cheapest solution. But where water is scarce, or costly, sewer discharge is false economy.

Heat needs. Almost every industrial, institutional and commercial plant uses hot water for some purpose—process, dishwashing, domestic services, etc. This water is heated either by steam or some fuel. Regardless of the heat source, fuel of some sort must be used to raise the water temperature, either directly or indirectly.

Going one step farther, it is easy to

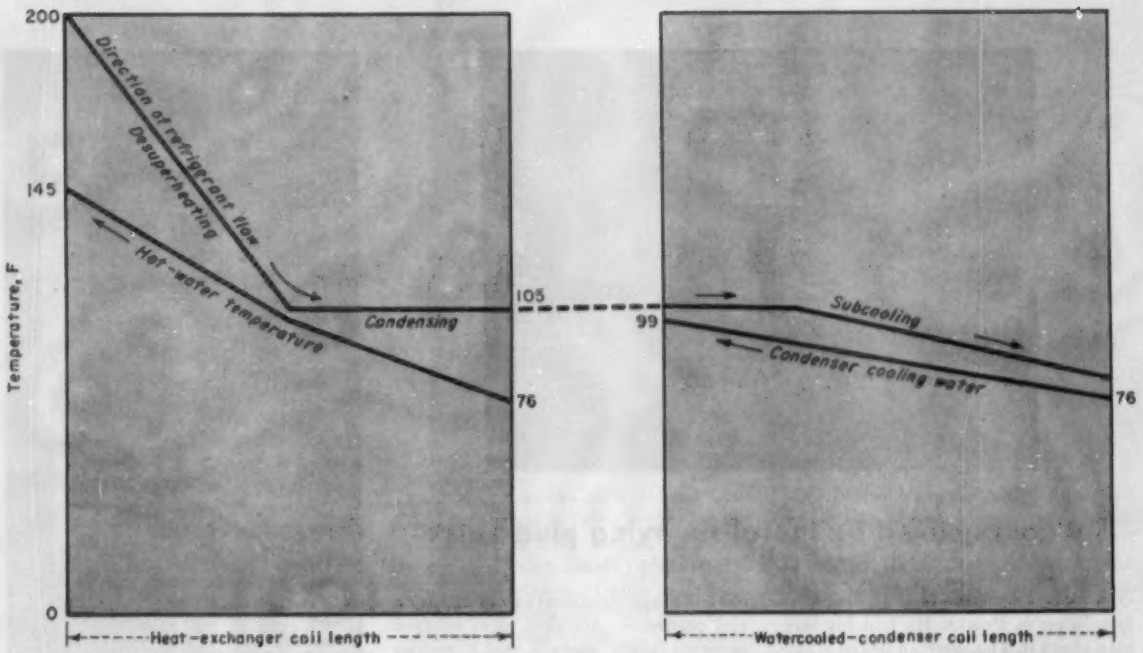


CHART SHOWING how refrigerant superheat and some of the enthalpy (heat) of condensation raise the temperature of water for domestic use. The exact temperatures met in any installation will depend on the refrigerant and amount of water used

see that in a plant having refrigeration compressors and a need for hot water, we're paying for cooling water to carry off heat we might use to raise the temperature of incoming water to a level suitable for our hot-water needs.

Locker plant. This installation, in Stone Ridge, N. Y., faced the same problems many others do today—rising fuel and water costs, reduced locker rentals and less packing business. How could costs be reduced?

Since much of the fuel was used for heating hot water and one or the other of the plant's two 7.5-ton Freon compressors ran continuously, we decided to use the cold water that normally went to the hot-water heater as our condenser cooling medium. This, we hoped, would reduce the fuel consumption of our hot-water heater, reduce the amount of power required for pumping water and relieve the evaporative condenser of some of its load.

Figuring heat rejection to the condenser at 200 Btu per minute per ton of compressor capacity, we estimated we could heat about 1.1 gpm per ton capacity through a 160-F temperature rise. With a 7.5-ton compressor operating continuously, the quantity of water that could be heated through this range is about 507 gph.

Photo and sketch, page 122, show the heat exchanger used. It consists of an 82-gal galvanized-steel tank containing a copper coil of the same diameter as the compressor discharge line. It is arranged so the compressor discharges to the coil, where incoming cold water cools and condenses the hot gas. From the coil the refrigerant liquid flows to the evaporative condenser, after which it enters the receiver.

Controls. Pressure-control switch actuated by system head pressure is wired in series with the regular switch for the evaporative-condenser blower and pump motors. Self-starting electric clocks are wired to the motor terminals of the compressor and blower.

Pressure-control switch is set to start the evaporative condenser when the head pressure is 5 psi higher than when condenser is operating. Setting is changed to keep this difference the same throughout the year.

Results. Our clocks showed the evaporative-condenser motors run only 7% of the compressor time. More than twice the required hot water was obtained. In May, the oil burner is shut off until fall, water temperature at the heater outlet reaching 220 F. Head pressure is lower than when the evaporative condenser is used without the exchanger.

Savings stack up like this: oil-burner fuel consumption is down 3000 gal per year—a saving of about 65%. Smaller but important savings are being made in pumping and evaporative-condenser power input. Other savings, which are just as real but more difficult to put into terms of dollars, are the reduced power input to the oil burner, and lower maintenance needs of the boiler and evaporative condenser. Also, these units should last longer than when operated continuously.

How-to info. A hookup like this might work in your plant. But careful engineering and design of the heat exchanger is a must. Also, local codes might influence the exact hookup you can use. So play safe, have the exchanger designed right for your job or you may find that the results you obtain are less than expected. There is no substitute for good design here.

PRACTICAL IDEAS ... *any one of these tips*

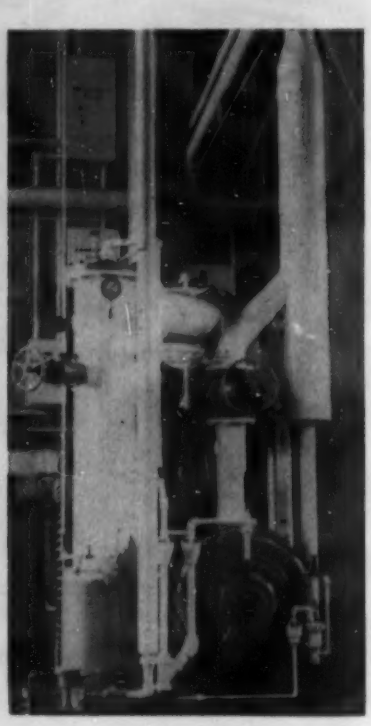
14 hours saved by metal-spraying plug valve

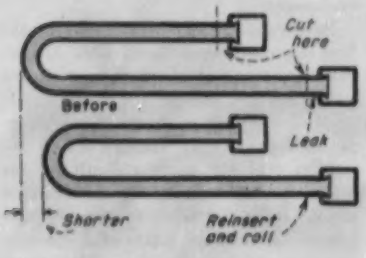
ONE OF OUR WELDERS read an article on metalizing in POWER. He told his foreman about it. The foreman began studying subject for a year. Numerous valves were sprayed, then field and refinery tested.

Now our reclamation department handles up to 5000 valves yearly. Most valves need reconditioning. In our refineries, valves control gasoline, oil, grease and other chemicals. Service causes rough combination of abrasion and corrosion. Stainless steel sprayed on worn plugs gives a much greater life. It resists corrosive action of chemicals and is much tougher in contact with mud and sand pumped up during drilling.

We metal-spray a 10-in. plug in two hours. It would take a welder two days to build up same job in our shop.

J SAMUELS *La Habra, Calif.*





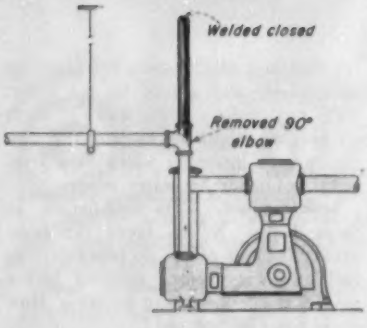
Repairing superheater tubes in place

RENEWING SUPERHEATER TUBE can be a mean, disagreeable job, especially if it's in center section of clusters. In our plant, superheaters 10 to 15 years old would begin leaking on fireside of tube. Leak was at edge of tube hole, in steam box or perhaps half to three-quarters of an inch beyond. We assumed these leaks were caused by light pitting or failure at thinner part of tube where it was rolled into the tube hole.

As rest of tubes were in usable condition, it was a waste of time and material to scrap them. We came up with a novel idea to use old tubes without entirely removing them from boiler. To do this, we cut an equal part from each end of tube, just ahead of the leak. We used a metal cutting saw similar in shape to a compass saw. This can be used easily between tube spacing, and doesn't alter outside diameter of tube.

After both tube ends were cut, ends remaining in tube holes were cut out, then cut ends of tube were entered and rolled into tube holes. We have used this method for several years with good results. While this slightly decreases superheater heating surface, it has not lowered superheat temperature enough to do any harm in our boilers.

E E SMITH *Clark's Summit, Pa.*



Now, no more piping vibration

WE HAD SEVERE vibration in discharge piping of a newly installed air compressor. It was so bad that supporting hangers, brackets and foundation bolts always came loose. Anchor piping to brick wall loosened bricks for a 3-ft radius.

We removed the 6-in. 90-degree elbow nearest compressor and fitted a long sweep tee, sketch. Then we installed a 10-ft. length of 6-in. pipe and welded outer end closed. This removed most of the vibration.

Recently, when installing our 2 new 750-cfm compressors, machines and

may save you a costly plant headache

STEVE ELONKA, *Associate Editor*

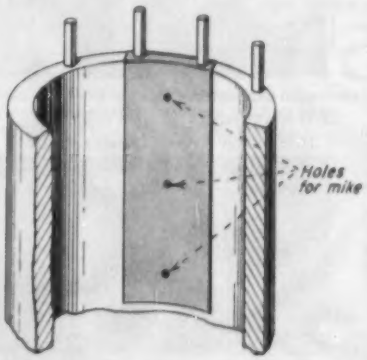
piping again vibrated. Foundation was solid, so trouble stemmed from severe air pulsations in discharge piping. Air receivers should dampen pulsations if large enough. Checking again, we found that with 224 cu ft of volume, it was suitable for 1900 cfm. Our delivery was 1500 cfm.

Answer was found by increasing size of discharge pipe close to each hp cylinder. We enlarged from 6 in. to a chamber 10-in. in dia by 7 ft 6-in. long, tapered again to 6 in.

This change caused discharge piping to resonate at frequency other than operating speed of compressor. But it has almost completely removed vibration. We welded length of 3-in. pipe into support chamber, photo, facing page, and closed it at outer end where floor flange was mounted. This also served as drip leg to catch oil thrown out of air passing into chamber. Oil discharges to waste through bucket trap.

There seems to be no formula for computing size of such a chamber. It's cut-and-try for each case. If engine indicator is hooked into the discharge piping next to hp cylinder, cards taken will show amplitude of pressure waves before and after installation of any enlarged section or extension piece.

F A HINCHCLIFFE *Lachine, Que.*



Guide for inside mikes

ON LARGE POWER CYLINDERS where it's hard to get accurate micrometer readings, I use device, made of sheet metal, see sketch. It holds one end of micrometer in place, especially if you can't get both arms down in cylinder. We can now mike cylinder in same place each time. That makes for more accurate data on its wear than without guide.

K H GOODLETT *Lobelville, Tenn.*

What would you have done?

IN PRE-DAWN HOURS of a winter morning, I was asked to help "get up" steam in a friend's heating plant. His oil burner serviceman couldn't promise help until that afternoon. Unless something was done, tenants and their employees would be greeted by 25 floors of atmosphere colder than Marmaduke Surfaceblow's cold logic.

Quick survey of plant revealed three idle "rotary-cup" oil burners. First looked OK—but wouldn't turn over. Second was completely dismantled and undergoing repair. Third had an obviously burned solenoid in oil valve.

I started on third one first. I disconnected the solenoid and turned oil valve upside down. This caused plunger to drop, holding valve in open position. Oil flow could now be controlled by the manually - operated metering valve. Burner started, ignited, and fired. I advised my friend *he* was now the solenoid. If burner should stop, he was to close oil valve.

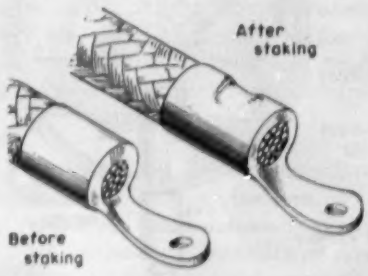
Next I started work on No. 1 burner with a test lamp. Water level, pressure-control, ignition oil temperature, modulator at low fire vaporstat were all OK. Fuses were intact. I removed cover from magnetic motor starter. Test showed pull coil energized but it failed to pull-in relay armature. Slight manual assist caused it to function and burner started to operate. Plant was operated in this way until burner was serviced. What would you have done?

H R MATHISON *Elmont, N. Y.*

I don't agree . . .

C H WILLEY, *May, p 129*, shows excellent ways of making emergency terminals. However, it's not good practice to make your own terminal lugs or to fasten them to wire with solder. Made-up terminal lugs are cheaper to use and are available in a wide range of styles. Besides, soldering lugs to wire is not only messy, but requires a lot of equipment, especially for field wiring. Usually it damages insulation beyond the joint, and may result in "cold soldered" joints that look all right, but fail under load.

Solderless terminals are practically identical in appearance to standard type, but they are fastened to wire by staking with special pliers. They are more expensive than standard lugs. Special pliers are not cheap either, especially large ones, but they give an excellent electric joint, save time and trouble. Only disadvantage is they might fail in fatigue under severe vibration. But for ordinary installation work they beat soldered joints and have underwriter's approval. I suggest you buy your terminal lugs, then stake them instead of soldering them, as Willey does.



P HONSON *State College, Pa.*

(Continued on page 126)

More PRACTICAL IDEAS

Begins on page 124

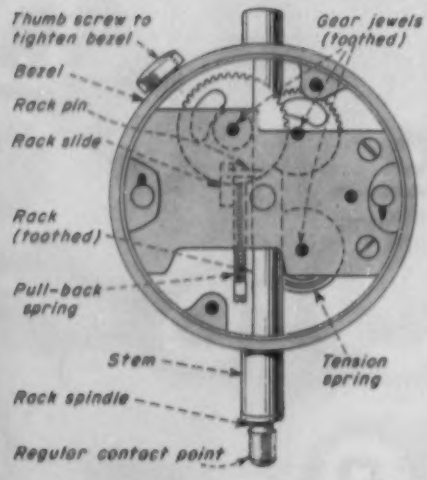
Here's your 'trick' of the month

COSTLY FIRE next to our plant caused great heat, water and smoke damage in our plant. In addition, all sprinkler headers, exposed to the heat, ruptured and required immediate replacement. Our maintenance crew was busy checking damage. Only two men had time to replace sprinkler headers. Here's how it was done.

We placed a platform on a hydraulic fork lift. While one man drove through plant where sprinklers had to be changed, other man on platform did replacing. This eliminated hauling stepladders under each sprinkler. We changed almost 100 sprinklers in 3 hours. This idea could be used for replacing light bulbs, painting ceilings, repairing pipes, many other jobs.

I E POLIKOFF *Brooklyn, N. Y.*

Take care of your dial indicator



DIAL INDICATOR is a sensitive instrument. Like a watch, it must be carefully maintained. When using it, clamp it securely to a fixture or holding device.

If clamped to end of a bar, as a test set or height gage, be sure bar is clamped in fixture as close to indicator as possible. This prevents deflection and allows for more accurate readings.

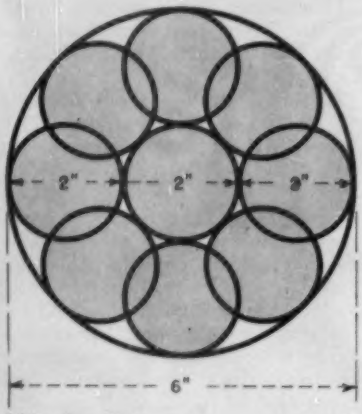
Always wipe rack spindle of indicator before using, especially if used around abrasives. Abrasives collect in movement and cause excessive wear. Indicators contacting oil or congealing fluids should frequently be taken apart, washed, and reoiled. Use solvents such as *Perm-A-Clor* to clean.

Never oil spindle bearings. Movement bearing rarely needs oil, but may be oiled with a good watch oil. Oil if used around heat, cleaning fluid, acids, etc. Be sure threads are clean before installing contact points, or adaptors, see sketch, that screw into ends of rack spindle. Then they won't cause rack spindle to bulge, indicator won't stick.

Don't tighten points and adaptors in rack spindle too much or rack-spindle pin or guide pin will loosen or shear off. While indicator is apart, examine back teeth or rack bar and meshing bar. Check for bent bars, loose screws on the dial, loose needle on jewels. Inspect pivot post that holds the spring. Check for chips in the case and rack slide. Examine rackpin for burrs. Check gears for proper mesh and proper tension. Examine dial for travel. AGD standard is 2½ turns.

Sticky indicator is found by placing thumb under the contact point and pushing slowly up until indicator hand reaches the limit. Repeat several times. If indicator's hand doesn't return to same point each time, indicator is sticking. Trouble is improper mesh between rack bar and gear. Keep in shape.

B A CROSSON *Cranston, R. I.*

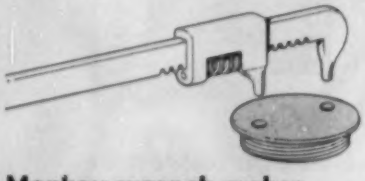


We don't agree . . .

CROSSON uses three 3-in. meters instead of one 6-in. meter, June, p 134. Area of a 6-in. pipe is 9 times that of a 2-in. pipe, not 3 times. For equal flow, he would need nine or ten 2-in. meters to overcome frictional losses, as editor points out. *Area = Dia sq × 0.7854.*

If Crosson can take this pipe size reduction, then reduce the 6-in. pipe to 4-in. and use one 4-in. meter to save cost of 6-in. meter.

H R MATHISON *New York, N. Y.*
V D HUNTER *Los Angeles, Calif.*
D A FLACK *Columbus, Ohio*
A CANNON *South Amboy, N. J.*



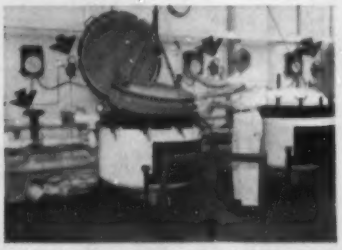
Monkey wrench makes adjustable spanner

A WORN AUTO-TYPE MONKEY WRENCH will give you more mileage as an adjustable pin spanner, sketch. File or grind jaws round to fit into holes. It makes a handy and rugged spanner.

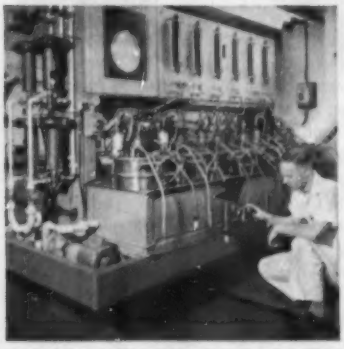
C H WILLEY *Penacook, N. H.*

(*Continued on page* 128)

Shaker room and incubator in Fermentation Department. Powers Temperature Recording Controllers are used here.



Ampoule Sterilizers regulated by Powers No. 252 Pressure Regulators and Valves.



Fermentation process in research pilot plant controlled by Powers ACCRITEM Regulators and FLOWRITE Valves.

A few of the many vacuum dryers equipped with Powers Temperature Controllers.

Below: Air Conditioned Room for Board of Directors and executive conferences.

POWERS *AUTOMATIC* temperature, humidity and pressure control

.... helps Abbott Laboratories bring better health to millions

Heating and Air Conditioning in many of the above buildings are automatically regulated by Powers Temperature and Humidity Control Systems.

Research at Abbott's has paid off in an unbroken dividend record, numerous stock dividends and splits. Many of their famous products such as Nembutal, Pentothal, Erythrocin, Iberol, Vi-Daylin, Selsun and Sucaryl have been developed in laboratories equipped with Powers control.

Versatility of Powers control used at Abbott's is indicated by some of the applications shown here and in the following installations: Air conditioning control systems for auditorium with 900 seating capacity, executive offices and dining room, cafeteria and animal rooms; also controls for tablet machines, demineralized water heaters, autoclaves and many other applications.

When you need automatic control for temperature, humidity or pressure, call your nearest Powers office or write us direct. An experienced Powers engineer will gladly help you select the right type of control for your requirements.

(e42a)

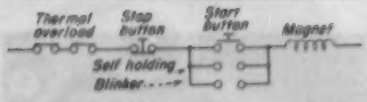
THE POWERS REGULATOR COMPANY

SKOKIE, ILLINOIS | *Offices in chief cities in U.S.A., Canada and Mexico*

Over 60 years of Automatic Temperature and Humidity Control

More PRACTICAL IDEAS

Begins on page 124



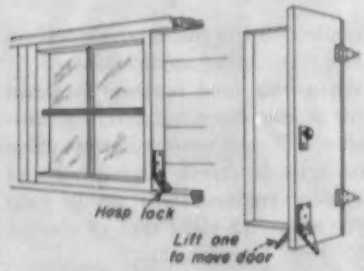
Magnetic starter for only $3.00?

WE ADDED a time delay gadget in form of a Xmas tree light blinker to our magnetic starter. This device is very useful in restarting important fans after a power failure. As these blinkers are not precision built, there's a variation in time delay. That prevents all motors coming back at same instant. One, in snapshot, has a time limit of 4-seconds cold and about 3-seconds hot.

Equipment consists of a magnetic starter, 2020-kd base, receptacle, blinker and a short-circuit cap. Sketch shows wiring method. You can see that blinker can only be in circuit a few seconds. It is then shorted out by self-holding contact. We made these up and installed for roughly $3.00. They are as easy to remove as to plug in. Just remove cap or blinker.

How do we restart electrical equipment following a power failure? We may short out or remove stop button. Start and stop button is an integral part of combination switch and magnetic starter. We do the stopping with main switch. This starter is handy.

H BRYAN *Montreal, Can.*



Use old hinges for lock

HINGES or hasps will wedge-lock sliding windows. They also make good door stops. They're not only positive in action, but also easy to apply.

C H WILLEY *Penacook, N. H.*

No more leaky boiler tubes

WE HAD INSTALLED a new horizontal cross-drum boiler rated at 60,000 lb per hr, at 450 psi. After 21 days of steaming, 7 rear waterwall tubes failed. A week later 4 more tubes failed.

Manufacturer could find nothing wrong with their new boiler. Neither could the firm supplying the feedwater chemicals.

I was crawling through the steam drum one morning looking for the trouble. I noticed that the ¾-in. internal feed line holes that carry the water to the boiler were pointed straight down. I pointed it out to the chemist and he agreed that this could be the trouble.

We turned the internal feed line around 180 degrees so that the holes pointed straight up. This slight change solved our problem.

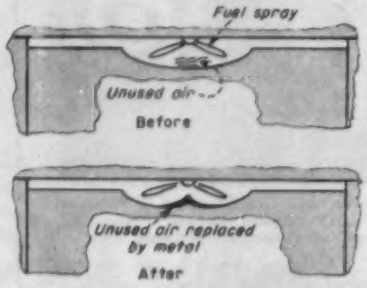
With the holes down, the feedwater was sent straight into the waterwall tubes without having a chance to mix with the phosphate in the steam drum. This untreated water damaged the tubes. Since correcting this, several years ago, we have had no tube failures.

H SPANGANBERG *Palmyra, N. Y.*

Handy button die holder

T-HANDLE DIE HOLDER won't always work. I find design shown very handy to hold my small round dies. It's a screwdriver type—handy for rethreading small studs in some tight places. Make holder in lathe and attach to piece of round cold-rolled steel. Drill into end as shown by dotted lines. That gives clearance for long screws being threaded. Very useful for maintenance.

C H WILLEY *Penacook, N. H.*

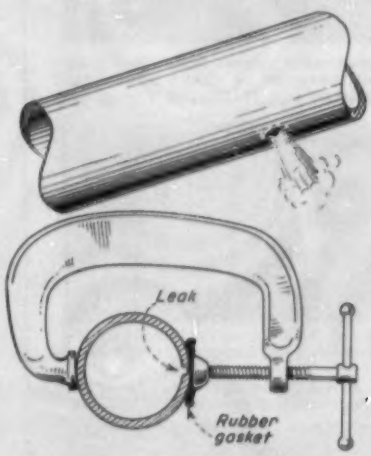


Here's why pistons crack

CAMACHO, June, p 134, solved piston-cracking trouble. But redesigning the piston is not a sure-fire cure for smoke and cracked pistons. His engine must have been poorly designed.

Reason for piston cracking is simple. Smoke in diesel exhaust indicates that fuel isn't burning when it should. Inefficient operation means a lot more waste heat for same output. And excessive waste heat in cylinder can overheat piston crowns. In Camacho's engine, it appears that the injector sprayed the usual cone of fuel in a normal manner. But air in center of spray cone could not get to fuel in time to burn properly. By replacing this stagnant air by metal crown, he forced air out into fuel stream, see sketch. There are engines where crown in center of piston head gives plenty of trouble.

P D HOBSON *State College, Pa.*



C clamp to stop leaks

TO TEMPORARILY CHECK minor leaks in piping and fittings, use a C clamp and a small piece of rubber sheet packing. This is a fast method that proves satisfactory until permanent repairs can be made. It may keep plant running.

H R MATHISON *Elmont, N. Y.*

MAINTENANCE?
what's that?

With YARWAY Impulse Steam Traps, what little maintenance there is can be handled in a jiffy. There's only one moving part—a tiny valve.

When the trap must be cleaned or repaired, it can be done right in the line—in a matter of minutes.

Other YARWAY features:

- **Stainless steel—body and internal parts.**
- **Gets equipment hot in a hurry—and keeps it hot.**
- **Good for all pressures without change of valve or seat.**
- **Easy installation—small size, light weight.**
- **Non-freezing at low temperatures.**
- **Six standard sizes, ½" to 2".**

Want proof of performance? Try a YARWAY Impulse Trap and Fine Screen Strainer FREE for 90 days in your own plant. For free trial or free catalog, write . . .

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.

This little valve—only moving part in a Yarway Impulse Steam Trap—floats on the condensate load. It gets equipment hot in a hurry and keeps it hot!

YARWAY impulse steam trap

OVER 1,000,000 YARWAY IMPULSE TRAPS SOLD—STOCKED BY 270 CONVENIENT INDUSTRIAL DISTRIBUTORS

Solving PLANT PROBLEMS . . . readers

The question

What is cure for steam-turbine vibration?

THE FACTS: In our industrial power plant we have a 5000-kw turbine-generator that's about seven years old. Since buying this machine we've opened it up twice, the last time about six months ago.

Turbine was OK until two weeks ago when an operator reported a vibration that's worrying us.

Naturally, we don't want to go through a complete overhaul now. But if the condition becomes more severe we feel that opening the casing may be the only answer. We don't want disk or bucket failures.

Do we need a complete balancing job? How will we do this? What's possible cause of trouble?
—*AH, May Power*

The answers

Vibration type can be spotted from data

IN MANY RESPECTS turbine spindle vibration is like pain in the human body. Just as pain warns you that something is wrong, undue spindle vibration is a sign that something is amiss. Finding the trouble may require a careful investigation by a vibration specialist or, with a little luck, a mental review of recent spindle history may spot the cause of trouble.

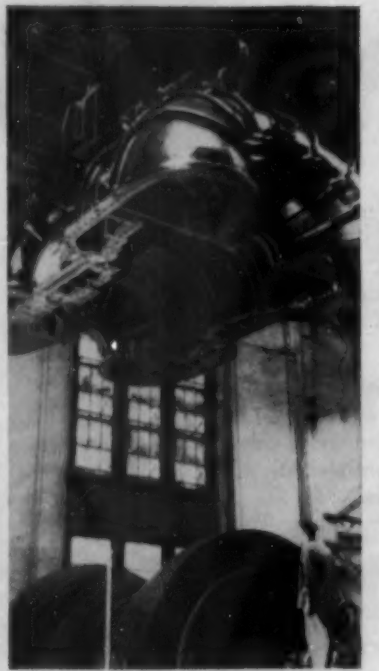
Spindle vibration may be caused by: (1) constant mechanical unbalance due to a bent shaft, missing blade, nonsymmetry in spindle construction (2) variable mechanical unbalance due to rubbing between spindle and stationary section, cool water contacting hot shaft, variable heat transfer to and from spindle (3) self-excited vibration due to oil whip, subharmonic resonance, friction whirl.

Usually the vibration shows unique characteristics that allow it to be identified if enough good data are available.

In this case, unless a review of events immediately preceding detection of increased spindle vibration reveals something obvious, the turbine manufacturer's service department should be consulted for their recommendations.

P C WARNER
Engrg Services, Steam Div
Westinghouse Electric Corp
Lester, Pa.

Lift upper casing and inspect turbine



JUDGING FROM *AH's* description, this is probably an impulse turbine with buckets attached to wheel rims or disks, with three or four bearings and a rigid or flexible coupling.

We advise against any attempt to balance the unit without first finding the cause of vibration. We are assuming that the unit has been running smoothly before this time.

AH should lift the upper turbine casing, left, and make a careful internal inspection to see if (1) any blades are gone (2) shaft runs true (3) thrust bearings are good (4) worm and worm gear are good and properly adjusted. Sometimes we find the steel shims under the bearing alignment pads worn thin enough to let the shaft get out of alignment.

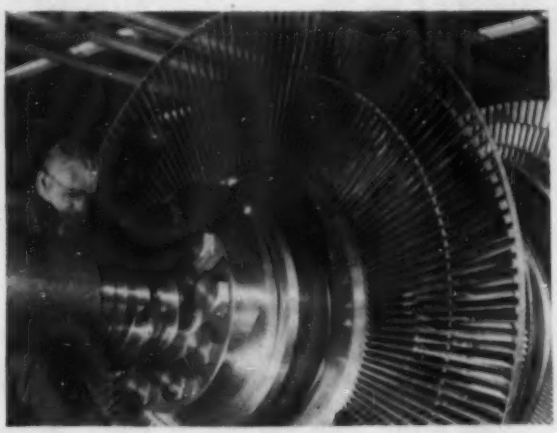
Generator's revolving field may be breaking down the insulation between turns on one side, which will make it vibrate. If turbine runs smooth without excitation and vibrates with excitation, then there could be trouble at that particular point.

Manufacturers make provision to insert weights in the revolving field of the generator for balancing purposes. An old method of finding out where to place the weight is as follows: Paint the shaft at each end of the field with whiting. Bring the machine up to speed and very lightly touch a pencil to the painted shaft. The marks indicate the high spot. If the shaft turns counterclockwise and the marks are at 12 o'clock, place the trial weight at 3 o'clock, in balancing plane.

C DEMERE *Memphis, Tenn.*

cure each other's headaches

HOWARD KALLEN, Assistant Editor



Where to look for vibration trouble

WHEN A TURBINE ROTOR is placed in the casing, alignment of all bearings and other rotating elements with their mated parts is a must. When removing the rotor all parts should be match-marked to assure correct assembly and fit. *AH* states that the turbine was opened about six months ago. It's possible that correct bearing alignment wasn't retained during reassembly.

To solve the problem, the casing should be opened and rotor removed. Rotor should be examined for chemical deposits and checked for indications of rubbing due to bowing or misalignment, photo, above. Tests should be run for static and dynamic balance. Manufacturer can do the best job since he has right equipment and trained men.

H B WAYNE — *Brooklyn, N. Y.*

Dynamic balancing machine simplifies job

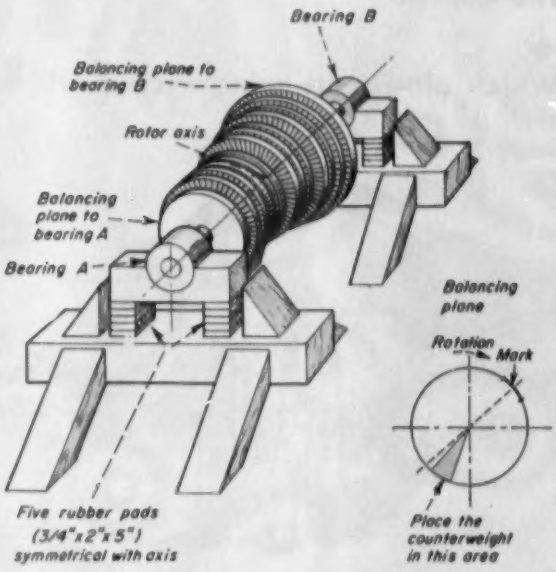
IF *AH* has reviewed all possible vibration causes and still hasn't solved his problem, he should check for balance.

A portable dynamic balancing machine can do the actual balancing without opening the casing to apply weights after each run. This electrical device indicates the peak-to-peak vibration displacement at each bearing and the angular position on the rotor at which the unbalance is located. After about four or five test runs *AH* will get enough data to find the quantity and position of balancing weights that must be added to the rotor to reduce or eliminate vibration.

The turbine manufacturer may rent this equipment to *AH* if someone can operate the instrument and know what to do with the results.

If an experienced man isn't available, *AH* can call in the manufacturer who will do the job (1) with the balancing machine or (2) through the lengthy, repetitive procedure of adding weights, operating the turbine and removing other weights that are found to be surplus.

A J BREUGELMANS — *New York, N. Y.*



How to balance turbine rotor

SIMPLE METHOD of balancing, even for heavy rotors, consists of placing rotor on two self-aligning bearings, flexibly mounted on wood support and rubber pads, sketch above. Pads allow horizontal oscillation of rotor.

First, clamp bearings *A* and *B*. Rotate rotor with motor-driven belt transmission. To eliminate drive's effect uncouple rotor by letting out the belt. Release bearing *A*. If rotor is out of balance it makes a wide deflection that can be measured with pencil or chalk hitting high spot.

Estimate counterweight size and attach it in the balancing plane of the first disk, see sketch. In about three to five tries an experienced man gets the right counterweight.

Repeat the operation with bearing *B* free and bearing *A* locked. When right counterweights are added to balancing planes, rotor turns quietly with both bearings free.

J RIVIERE — *Santa Fe, Argentina*

Vibration meter can pin down source

ANY TIME a turbine-generator vibrates excessively, it's time to take a close look at the unit. Since *AH* says that the unit is seven years old and the vibration showed up only recently, he can probably rule out a poor foundation. But he should check to see whether the foundation has moved.

If foundation is OK, borrow a vibration meter and test vibration magnitude at different spots on the unit. This can help pin down the source, within limits.

Also, check all present pressures and temperatures against the log for the period before undue vibration was spotted. If the gland isn't getting enough water, it can cause vibration. And this is evident from the log. If nothing is found that's causing vibration, by external inspection, *AH* will have to open up the unit.

D H MARSHALL — *Evanston, Ill.*

Turn page for ideas on air conditioning

More PLANT PROBLEMS

Begins on page 130

The question

Which air-conditioning system will suit our building best?

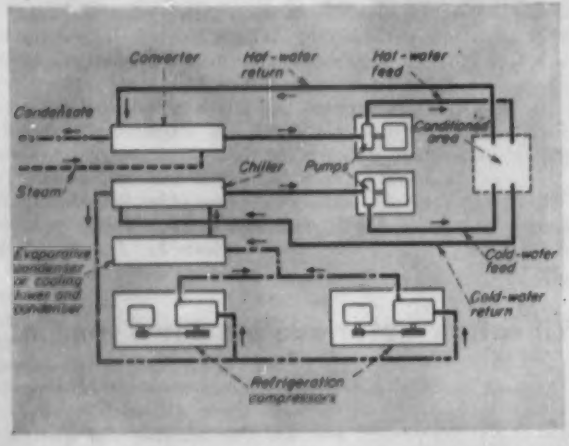
THE FACTS: As engineer for a hospital that's about to go ahead with a building program, I'm faced with the problem of deciding between several proposals for air-conditioning the new building.

The new hospital will provide an additional 250 beds in a 6-floor building. We're in the Midwest where the highest recorded temperature is 110 F. Design dry-bulb temperature in common use is 95 F. Design wet-bulb temperature is 78 F.

Proposals generally divide themselves into two groups: (1) Fully centralized system; filters, air washer, fans and refrigeration machinery are centrally located. Ducts distribute conditioned air to hospital rooms. (2) Partially centralized system; refrigeration is handled centrally. Chilled water is distributed to several areas in the building, where coils handle actual cooling.

What are the relative merits of these two systems for a hospital of this size? How should our machine room be laid out?—*JM, May Power*

The answers



Design tips for *JM's* air conditioning

BEST SOLUTION for this hospital air-conditioning problem is a centrally located chilled-water system, with separate air-handling units in several zones. Hospitals demand different temperature-humidity conditions in different locations, at the same time.

Advantages of such a setup are: (1) Less refrigerant charge is required. (2) Large central-supply ducts can be eliminated. (3) Noise, odor and germ circulation through the entire building are banished. (4) Outside air can be tempered for proper humidity and retempered for right temperatures needed in different zones. (5) Equipment failure will not require complete shutdown of system. One zone can be shut down at a time for air-handling unit maintenance.

A typical equipment room is shown at left. Here are some important pointers: Handle cooling load with more than one compressor to prevent short cycling under low load conditions. Control primary compressor with an aquastat in the chilled-water line, in conjunction with a delayed-action pressurestat to operate the secondary compressor. Refrigerant condenser is a common unit for all compressors.

An evaporative condenser or cooling tower can be used, depending on location of the unit.

Heating water can be supplied at any temperature, provided pressure is great enough to prevent boiling.

D M JARDINE *Colorado Springs, Colo.*

How to install chilled-water system

CENTRALIZED air-conditioning system with ducts isn't practical for this hospital. A central refrigeration plant, supplying chilled water through coils placed adjacent to conditioned areas, is the cheapest, most efficient solution.

Average hospital room needs about one-third fresh air at the unit intake, the balance being recirculated air.

Install main refrigeration unit in the basement. Compressors need substantial foundations and isolating bases. Use flexible piping to condensing-water and chilled-water pipes.

Fan rooms should be near conditioned areas. Select a centrally located spot where fresh air can be drawn. If floor space is at a premium, use horizontal-discharge ceiling-mounted units. These can be installed over work areas, in closets or in corridors.

L W FITZPATRICK *Jefferson City, Mo.*

New questions, also more on air conditioning, p 134

How Grid-Type Phase Control IMPROVES RECTIFIER OPERATION

Separate circuits — one for firing, one for phase control — give important operating advantages in excitron rectifiers. The excitation circuit maintains a continuous arc that makes the excitron rectifier much less likely than other types to lose excitation during operation. A separate circuit utilizes the deionizing grid to obtain phase control.

Only excitron rectifiers provide separation of these two functions in separate circuits. Improved operation is the result, because one function is never sacrificed to the other — you get optimum operation from each.

Grid-type phase control permits operation in the clean region near the anode where ion density is lowest, instead of on the surface of the cathode mercury pool where the mercury may be contaminated. Reliability of phase control does not depend on the condition of the mercury. Only excitron rectifiers can give you this important operating advantage.

For more information on grid-type phase control of excitron rectifiers, consult the A-C office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4872

ALLIS-CHALMERS

More PLANT PROBLEMS

Begins on page 130

Zoned air conditioning is more flexible

PARTLY CENTRALIZED SYSTEM, with refrigeration handled centrally, would provide better air conditioning for the hospital job described by *JM*. With the exception of a high-pressure conduit-type installation, a fully centralized air-handling system would never be flexible and its operation would be a painful experience in a 6-floor hospital building.

Zoned air conditioning holds special advantages for a hospital because it provides absence of air contamination from one area to another and avoids the transfer of odors between areas.

Central refrigeration with a chilled-water system permits effective transfer of the cooling medium to the various units, regardless of service. The refrigeration plant can utilize modern centrifugal compressors that are easy to supervise, economical to maintain and that provide excellent power versus load characteristics at all ratings. Various drives are available, ranging from hermetically sealed motor units, through variable-speed, high- or low-voltage motors and steam-turbine drives that improve plant heat balance.

E F WEHLAGE *Fairport, N. Y.*

Can *JM* put machine room on roof?

HOSPITAL air conditioning is probably one of the toughest air-conditioning jobs to handle.

JM is going to need separate systems, or at least separate zones and all outside air for each operating room. He will have to zone his general air conditioning for sun load. His postoperative rooms should be separated from general wards. The maternity section and nursery need separate systems.

One of the big factors is the humidities and temperatures required at different times. Also important is the separation of systems to prevent spread of contagious diseases.

If *JM* is considering a cooling tower, why not put the machine room on the roof and save condenser-water piping?

M N COLLISON *Flin Flon, Manitoba*

Use three units with common duct

AIR CONDITIONING can be designed for easier maintenance by using at least three complete air-conditioning systems, each one serving two floors.

A common duct between the three units permits operation with any one, two or three machines.

Don't forget proper insulation of ducts, hangers and machines from each other and from the building to eliminate noise, vibration.

C G HOWARTER *Canton, Ill.*

Low noise level important

GETTING DOWN TO DETAILS on the chilled-water system, chilled water is pumped to the convectors, takes on heat and returns to the chillers, without spreading odors or disease — as might happen with a completely centralized conditioning system.

Individual coils and blowers can cool small private rooms. Larger rooms, like ward space, might use duct work and larger coils with a central blower.

In any event, all effort should be directed to a low noise level. Use low-speed fans and hold coolant velocity in pipes to three fps, maximum.

JM should look into the possibility of using self-contained window air conditioners in ½-ton and ¾-ton sizes. These can supplement the chilled-water system and keep the cooling tower down to a reasonable size.

A M PALMER *Brooklyn, N. Y.*

YOUR SEPTEMBER PROBLEMS

1 How can I avoid excessive pressure drop in our compressed-air system?

I'm responsible for power services in a good-size foundry that's about to expand its compressed air system. We use compressed air for molding, sand ramming and for a multitude of other purposes.

Compressor we're buying is a single-stage, horizontal, double-acting, motor-driven machine that's powered by a 50-hp motor. Piston displacement is 350 cfm at 100 psig.

Our present machines, also rated at 100 psig, have difficulty maintaining the required pressure at the pneumatic tools. We've checked tool manufacturer's recommendations and feel that we have enough compressor capacity to supply the tools.

As I see it, either our distribution piping system is poorly designed or we're losing air through leaks. Naturally, we want to rectify our mistakes when we install the new compressor. Can *Power* readers offer advice on avoiding excessive pressure drop?—*AL*

2 What's best way to take deaerator out of service while under load?

Our deaerating heater, mounted on a storage tank, serves two 200,000-lb-per-hr boilers whose steam conditions are 900 psig, 950 F. Water entering deaerator is 180 F, 110 psig, while steam entering it is 550 F, 110 psig.

The storage tank holds 125,000 lb of 110-psig saturated water. The boiler feedwater is regulated by 3-element controls.

The deaerator level-control valve is equipped with block and bypass valves, and the deaerator and storage tank can be bypassed through a line that leads from booster pumps to boiler-feed pumps.

We want to cut out the deaerator to replace some valves. But we want the colder feedwater to have least possible effect on boiler operation and combustion conditions.

Will *Power* readers give us their recommendations on how to go about doing this?—*HS*

Sit down right now and answer one or both of these problems. We'll pay extra for answers with photos or sketches.

DO *YOU* TAKE GASKETS FOR GRANTED?

In the costly processes of today's industry — where fluids are confined in searing heat and brutal pressures — taking a gasket for granted is serious business. The price of gasket failure is measured in damaged equipment, plant "down-time", danger to personnel.

No one at Flexitallic has ever taken a gasket for granted. Each Flexitallic Spiral-Wound Gasket is engineered to be the right gasket for the right flange for the right seal. For 43 years, Flexitallic has worked toward perfecting this principle. Small wonder more and more engineers are specifying on orders: "Flexitallic — do not substitute".

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O. D.

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ARGUMENTS . . . *pros and cons from readers' letters*

ALTHEA THORNTON, *Assistant Editor*

Marmy's 'superpressure cooker' bothers him

ALONG WITH your many other readers, we enjoy Marmy's tales and suffer his woes. But occasionally his stories leave us skeptical. For example, there's that "knibbling pin" of many months ago.

And in June POWER, the cook lost his minestrone soup under conditions that *could* occur as Marmy describes. But I wonder how that pea and string of spaghetti managed to stay intact in the gage glass of that superpressure cooker he called a boiler. How come the boilers didn't foam? The steam tables show a temperature of 402.7 for 240 psi.

H M NEUHAUS *Philadelphia, Pa.*

MARMADUKE'S NOTE: Bilgewater on Herb Neuhaus for squawking about any statement I make. If he had sailed aboard merchant ships back in the good old days, he'd know that some of the peas the shipping lines tried to feed us were so tough we used them for ball bearings instead. And a few strings of spaghetti were always case-hardened with cyanide so the boys wouldn't go soft.

About those boilers foaming—they sure did. But surface blows stopped that. Besides, a kettle of soup divided into three boilers isn't bad.

When it comes to knibbling pins, I can see Herb is a dry-land sailor, or he wouldn't have to wonder.

Improved way to put boiler on the line

I REFER TO B H Coker's letter about putting boilers on the line (p 200, May POWER). In the circumstances he describes, I think it's better to open the check stops positively before raising steam. This helps warm up the steam line gradually. But even more important, it removes the risk of serious accident should the stop valve stick to its seat.

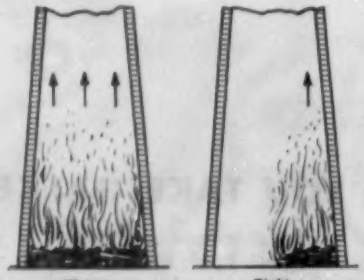
Perhaps Coker's valve has never stuck, but it can happen. If it does, the boiler pressure builds up until check stop breaks off its seat and slams open. It doesn't take much pressure behind the valve to crack the valve casting, if nothing worse.

All British Navy ships have check stops. These worked well in reducing trouble when boilers were damaged in action. Strict orders required lifting valves off their seats physically when raising steam. A number of accidents and some fatalities had been caused by valves slamming open.

Many times I have put a boiler on the line by opening a check stop; usually there is about 10 psi more in the boiler than in the header. Ordinarily valve starts to open as soon as the hand wheel is backed off a little, but sometimes it sticks on the seat and a "U piece" must be used.

Ten-psi difference across a 12-in. valve is 1130 lb; this is quite enough to knock the bonnet off a valve casting.

PAUL HONSON *State College, Pa.*



More on starting draft

In solving that chimney problem, "Tall chimney + fan = no draft?" (May, p 146) Marmy could have included more detail on lighting fire in the stack's base. Years ago a large veterans' hospital in western Massachusetts was trying to heat up a new stack to get draft, but they ran into trouble. Brick stack cracked about seven feet from top. My sketches may be of help.

At left, fire has to try lifting cold air across the entire cross section of stack. At right, only a partial cross section has to be lifted at the start. This gives positive circulation a chance, which results in thorough heating.

A F SHEEHAN *Springfield, Mass.*

Marmy is absolutely correct. Several times I have had to build wood fires in the base of a 125-ft brick stack for natural-draft boilers, or stay out of the boiler room because of heavy smoke.

EMIL MUESSIG *Indianapolis, Ind.*

Best scheme for lamp replacement?

WE DIVIDE our buildings into areas, and record on a chart the number and type of lamps for each area, together with date of complete relamping, date of inspection and number of lamps replaced during these inspections. We use lamps salvaged during relamping as our replacements during these inspections. Checking the chart for replacements guides us in timing the next relamping.

Under this plan, relamping is staggered on original installations and work load is spread throughout the year. This makes for good control of lamp-maintenance labor.

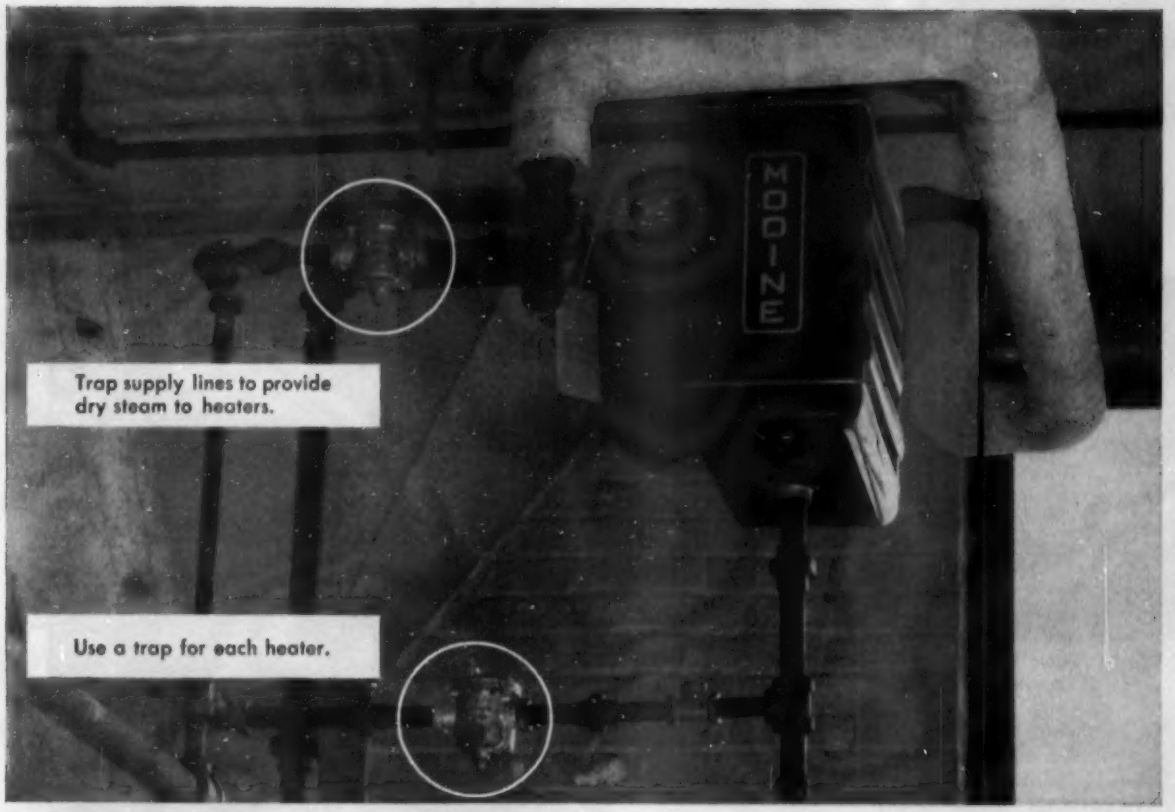
Fixtures are dry-wiped or washed as needed during the relamping period. All work on fixtures and lamping is done outside of office and regular working hours.

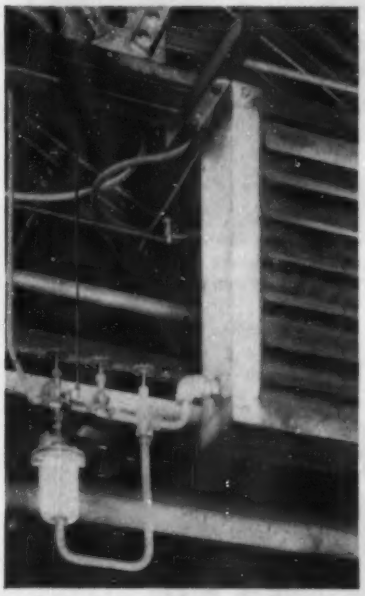
Lamps are ordered when needed, thus cutting inventory. Better light is maintained throughout the plant, resulting in better displays, better appearance, greater and more accurate production.

The initial lamp cost is slightly greater per fixture under a relamping plan, but relamping costs are reduced by 50%. Our trouble calls and outages are reduced by 95%.

Another advantage of this system: Defective batches of lamps are detected almost immediately. Manufacturers are glad to find out about this.

DALE WEUM *Minneapolis, Minn.*





Use a bypass above trap where heater must be kept in operation at all times. Note neat hookup possible with Armstrong vertical connection trap.

Tips on Trapping Unit Heaters for Full Output and Low Maintenance

• If unit heaters are clean and the steam supply and return lines are adequate, their performance will depend entirely upon the steam trapping. Here are some trapping pointers to insure plenty of heat when it is needed:

1. Trap supply lines to take care of condensate formed by radiation loss.

2. Use one trap for each heater. Two or more heaters drained by a single trap will fail to deliver maximum btu output.

3. Size traps properly. Many a unit heater is handicapped by a trap lacking adequate condensate and *air* handling capacity. The few dollars extra for larger traps insure fast heatup, full output and freedom from coil corrosion.

4. Install traps correctly. Put trap below and close to heater. Install a bypass around the trap if the heater must be kept in operation at all times. A shut-off valve in the discharge line facilitates trap inspection. Use of check valves and strainers is dependent upon piping conditions and the traps used.

5. Protect against PRV failure where freezing could occur. Sometimes heaters supplied with reduced pressure steam are installed where freezing could occur if traps failed to open. In this case select traps that will open at maximum steam supply pressure and still have adequate capacity at reduced pressure.

FREE ON REQUEST—COMPLETE INFORMATION on the above points, diagrams, selection data, tables and additional recommendations are contained in Armstrong Bulletin No. 2312. Also includes BTU output ratings for all models of 30 makes of unit heaters. Call your local Armstrong Factory Representative or write:

ARMSTRONG MACHINE WORKS
812 Maple Street • Three Rivers, Michigan

STEAM TRAPS FOR EVERY REQUIREMENT — APPLICATION ENGINEERED

ARMSTRONG STEAM TRAPS

HOW TO

use portable ventilator

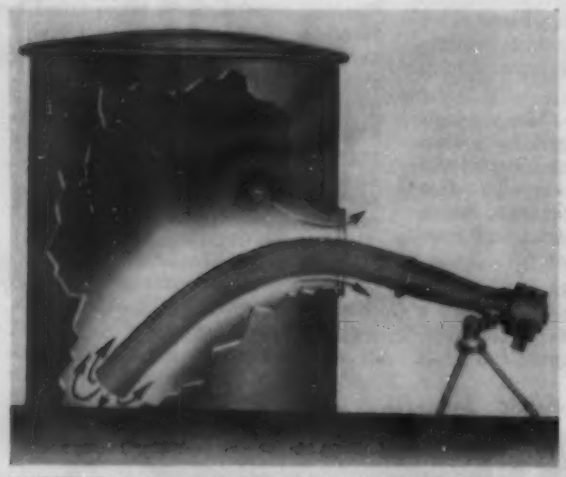
► PLANT MEN work in boilers, vats, reactors, underground manholes, pipe galleries, etc. They also weld in the open where harmful fumes are dangerous. Answer is a portable ventilator. Never send a man into a confined place without first ventilating.

It's better to inject fresh air at high velocity than to exhaust from confined spaces. This is true unless fumes are heavier than air—for instance, welding fumes. Injecting and exhausting have same effect theoretically, because every cubic foot of air or fumes withdrawn permits equal amount of fresh air to enter. But danger is that fresh air is often drawn directly to suction inlet, leaving large area unventilated.

Fresh air drawn at high velocity into confined area begins a whirling action, stirring fumes thoroughly and forcing them outside. For localized ventilation, 1000 to 1500 cfm is OK. In large area, run ventilator long enough for several complete air changes. Make sure all fumes are out before a man enters. For complete removal of fumes, inject air at 3000- to 4000-fpm velocities. This depends on cubic contents of vessel and volume of air delivered by ventilator. *Courtesy, Coppus Engineering Corp, Worcester, Massachusetts.*

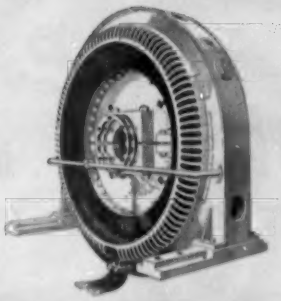
WELDING FUMES in closed or open spaces must be drawn away by ventilator. These fumes are always dangerous to a welder

HOT FURNACE is kept cool in area where mechanics are working. The ventilator is quickly pressed into service in emergency

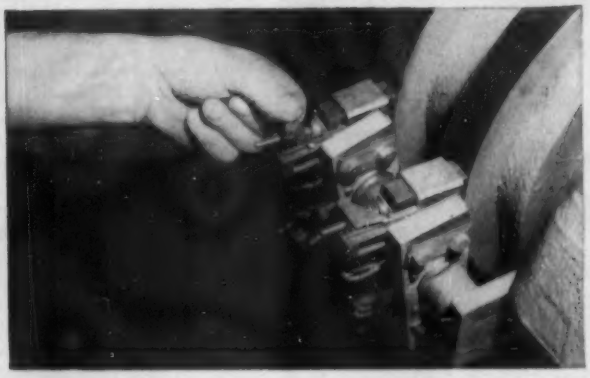


INJECTING fresh air to confined space gives whirling action, stirring the fumes thoroughly and forcing them to outside

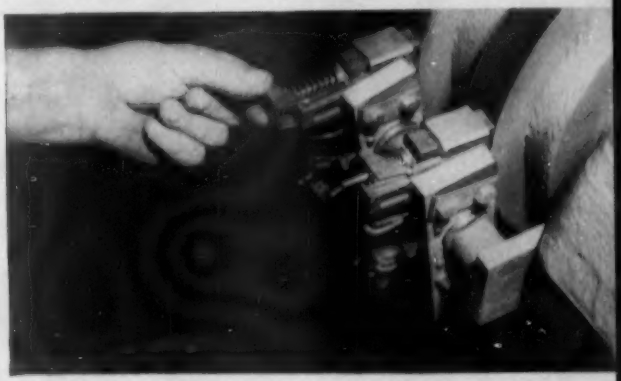
CABLE MANHOLE is made safe for men to enter in few minutes. Sewer gas and other fumes are quickly expelled by this unit



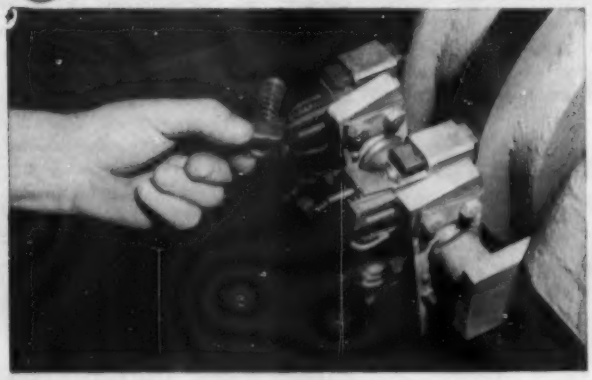
HOW G-E SYNCHRONOUS MOTORS REDUCE MAINTENANCE COSTS



10 seconds. To start changeover, unscrew lead, release lock.



15 seconds. Slide lock back.



25 seconds. Swing locking device to one side. Remove old brush.

Install new. Changeover made in less than 60 seconds.

One-minute Brush Changeover!

As experienced motor maintenance men know, replacing worn brushes can be time consuming and costly. Not so on General Electric low-speed synchronous motors!

G.E.'s calibrated spring-loaded brush holder makes brush removal so easy it can even be done with one hand if necessary. You just unscrew the lead, release the spring lock, remove the worn brush and slide in the new. The whole operation takes less than 60 seconds per brush!

In addition, the brush holder's calibrated pin gives a clear indication of brush wear. Simply by slipping the lock down the holder you can maintain proper pressure and obtain optimum brush performance.

If you want a motor that is easy to inspect, call your nearest G-E Apparatus Sales Office. A sales engineer will gladly explain the many other advantages of G-E low-speed synchronous motors. General Electric Co., Schenectady 5, N. Y. 770-37

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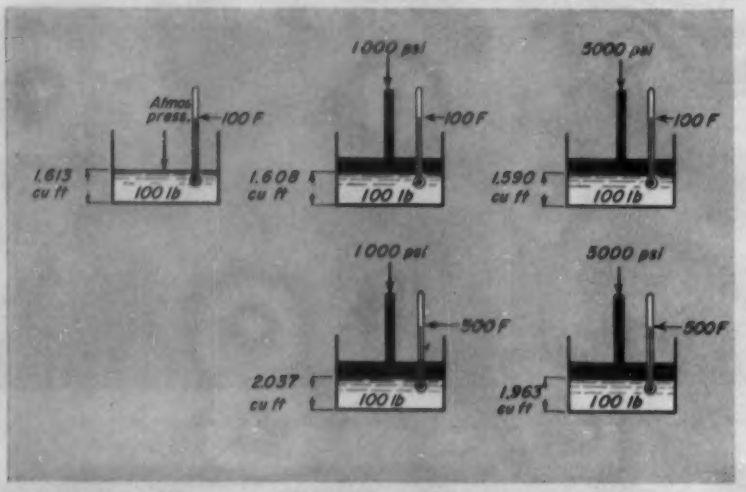
BASICS . . . bringing engineering theory down to earth

HOWARD KALLEN, Assistant Editor



COMBINED HEATING AND COMPRESSION of this cylinder of water changes its density. By showing pressure and temperature changes in separate steps, we tell what their relative effects are. Note that temperature rise causes biggest density changes

FLUID FACTS—1:

How density changes

► WITH THE COMPLETION of Tod Waldron's series on "How Fuels Burn," we're going to swing over to a new topic: The nature of fluids—their properties, how they act at rest, and how they behave in motion.

To get the ball rolling we'll equip ourselves with the basic tools — the meaning of fluid properties and how they help us predict the behavior of fluids. Items coming under this heading are density, specific gravity, compressibility, viscosity.

But before taking a close look at these, let's find out exactly what a fluid is. Big difference between fluids and solids is the ability of a solid to hold definite shape, apart from its containing walls. While this isn't strictly true—since some viscous fluids act like soft solids—we can use it as a practical definition. Taking another viewpoint, molecules of fluids have great freedom of movement and are relatively far apart, while molecules comprising solids can move only within a limited space. So when we talk about fluids we're referring to all the common liquids and gases.

Density. An important characteristic of all fluids is density, the weight of a specified volume—usually a cubic foot. Common figure for water is 62.4 lb per cu ft. But density changes with temperature, pressure and chemical content. Maximum water density, at atmospheric pressure, is 62.43 lb per cu ft, at 39.2 F. Either boosting or reducing water temperature, from this figure, reduces density. For instance, at 32 F, water density is 62.42. At 45 F, it's also 62.42 lb per cu ft. At 212 F, density slides back to 59.8. But unless we're dealing with high temperatures or need precise results, we can usually use 62.4 as a working figure for calculations.

Now let's see how pressure affects water density. If we hold temperature constant, let's say at 100 F, and try to compress a pound of water, we'll get only a small volume reduction—even at very high pressures. At 6000 psi, density climbs only slightly to 63.1 lb per cu ft. That's why we often say that water is an incompressible fluid — a statement that's not strictly true, but simplifies figuring at the cost of minor sacrifice in accuracy.

Salt water is heavier than fresh water because of higher density of chemicals in solution. And we can easily account for the difference by using 64 lb per cu ft as an average density value for salt water.

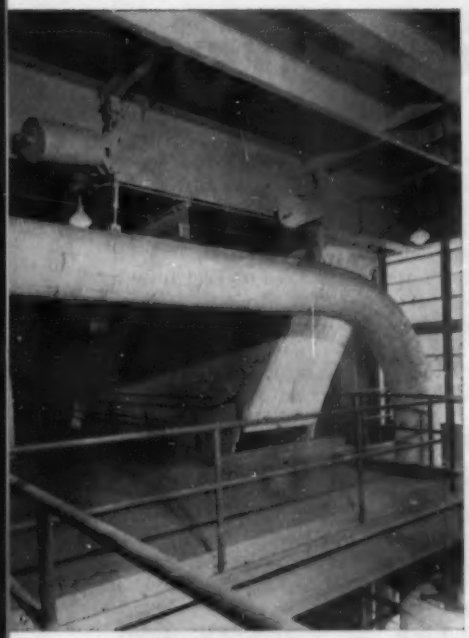
Specific volume. Often it's more convenient to use the reciprocal of density —specific volume — especially when we're dealing with vapors and gases. Specific volume figures, cu ft per lb, are readily available in steam and gas tables. We'll use some of these data later on to work out typical problems.

Drawing, left, points up the combined effect of pressure and temperature on water. Following cylinder of water from left to right we can see how density increases (specific volume decreases) with rising pressures. Following water from top to bottom, we note density drop off (specific volume goes up) with rising temperatures.

Specific gravity. Still another index of fluid's density is specific gravity. This figure compares fluid's density to the density of another liquid or gas that's used as a standard. If we know liquid's density we can figure its sp gr by dividing by 62.4—the density of water at 60 F, at atmospheric pressure. Sp gr values for liquids range from 13.55 for mercury to 0.79 for ethyl alcohol.

Base for sp gr of gases is air at atmospheric pressure, usually at 60 F. Dividing gas density, lb per cu ft, by 0.076—standard air density—yields gas sp gr. Typical values range from 1.52 for carbon dioxide to 0.07 for hydrogen.

Main advantages of using sp gr for figuring are: (1) Since it's a ratio of two quantities that have the same dimensions, it's dimensionless. So we needn't worry about units. Sp gr data are consistent with any notation—cu ft, cu in., lb, grams, etc. (2) We can measure liquid sp gr directly with a hydrometer.



This station, having an initial capability of 276,000 kw, was designed and erection supervised by Gilbert Associates, Inc., Reading, Pennsylvania. It is one of the most efficient and low-cost stations in the country.

At the new Shawville Station of Pennsylvania Electric Co.

it's NAVCO Piping throughout

Over 37 miles of pipe were installed by Navco in this highly efficient reheat station and all necessary prefabricated assemblies, in excess of 2,000,000 lbs., were produced in Navco shops. For field welding only, more than 15 tons of electrodes were used.

The photo above shows one of the bends required for the Main Steam. It is 16″ O.D. forged and bored with a wall thickness of 3.084″ and weighs 5½ tons. Material is ASTM A-335 P-22—2¼% Chrome. Operating conditions are 1850 psi at 1050°F. initial, with 1000°F. reheat.

The photo at the left shows this bend in service supported by dependable Navco Counterpoise Hangers.

In the past three years alone, Navco Piping has been installed in Central Stations generating in excess of 4,000,000 kw.

Next time you have a Piping job requiring reliability in performance and careful attention to every small detail, Navco will welcome the opportunity of quoting you.

Call, wire or write today!

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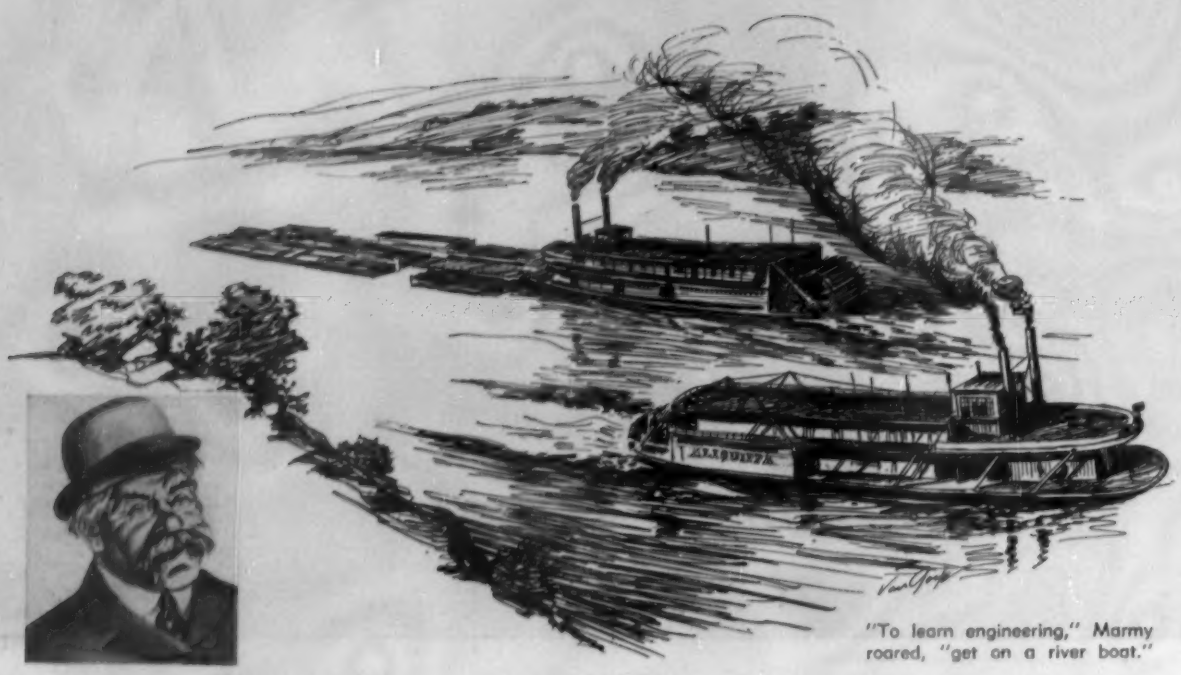


"To learn engineering," Marmy roared, "get on a river boat."

Marmy takes a tow down river

► "BILGEWATER on you stationary and marine engineers, squawking about your tough jobs," thundered Marmaduke Surfaceblow in his foghorn voice at the Bent Propeller Bar yesterday. "You guys won't know what engineering is until you do some river steam-boating on our inland waterways."

That's the blast I heard when I barged into the Bent Propeller to see if the old consulting engineer was around. Marmy was aboard, all right, all 6 ft, 4 in. of him. As always, his old gray bowler was perched on his gray seaweed-covered head. He backed up against the crowded bar, anchored his huge thumbs into the armpits of his checkered vest, then surveyed his startled audience for a second. As soon as the noisy cash customers clammed up after that first outburst, Marmy roared away in his foghorn voice.

"Back in 1926, I made a trip as Chief Engineer on the steam stern-wheel tow boat *Aliquippa* out of Pittsburgh, Pa. She was built in 1914. Her steel hull was 152 ft long, 29 ft, 10 in. wide, and she drew 4 ft, 8 in. of water.

"*Aliquippa* had four Western-style return-flue boilers, carrying 235-psi steam. Boilers were 26 ft long, 4 ft in diameter. They were hand-fired with coal. Two Rees horizontal-tandem compound condensing engines exhausted into a shell-and-tube condenser. Engines' high-pressure cylinders were 14 in. in diameter, low pressures were 28 in., and both had a common stroke of 7 ft. Those engines developed 600 hp at 18 rpm and were set on cylinder timbers.

"As *Aliquippa's* Chief, I stood the two forward watches. That's from 6 am to noon and from 6 pm to midnight. My Second Engineer stood the two after watches, from noon to 6 pm and from midnight to 6 am.

"Both the Second and I had a Striker Engineer on watches. These men did the oiling and other leg work. After three years' time they could sit for their Second Engineer's examination. (ED. NOTE: Today this is reduced to two years.) Two firemen and one coal passer rounded out each watch.

"On my first trip we backed out from Pittsburgh with a tow of 15 barges, all loaded with steel for Memphis, Tenn. On the river, they call those barges a tow, but they were pushed in front of the tow boat and hitched up forward. One barge was hitched on either side of the *Aliquippa*, with others four abreast hitched forward of those two. We also had two fuel flats loaded with coal. These flats are usually shoved along in the duck pond. That's the open body of water between the bow of the towboat and the barges tied around her. Empty fuel flats are left along the way and full ones picked up instead. After the coaling aboard the towboat is used up, a whitewashed plank is dropped from the towboat to a loaded fuel flat. Then coal passers wheel the coal aboard in wheelbarrows, as needed. Whitewash helps men see the plank at night.

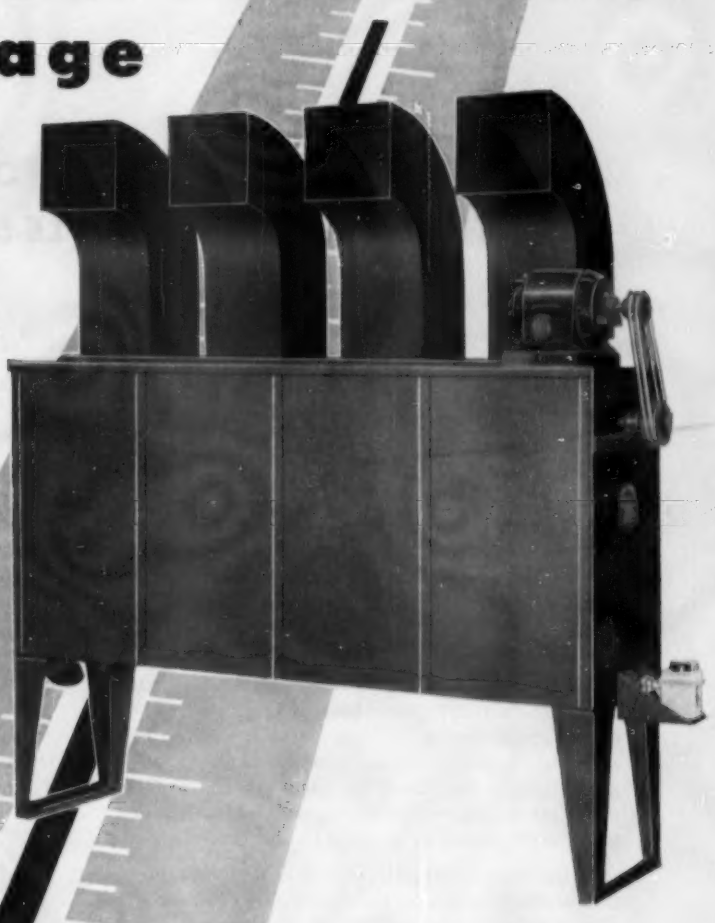
"Our trouble started when we got to Lock No. 6 below Rochester, Pa. There we hit a lock wall one hell of a crash. One of the two chambermaids was in the kitchen drinking coffee at the time. That crash sent her against the cook stove on her bottom timbers. Her arms were so badly burned that we had to rush her ashore to the hospital.

"After that, things went along OK until we reached Paducah, Ky. Just before getting landed, we broke the starboard pitman strap. That's the iron strap clamping in the wooden connecting rod. Strap was 4 in. wide, one-half in. thick and 30 ft long. By the time we had taken the strap off, welded it and got it back together again, we had lost another 14 hours.

"A few days later, at Cairo, Ill., I wanted to clean boilers. But the Cap-

(*Continued on page* 180)

YOUR FUEL COSTS go down when Clarage Unitherms go in...



AMONG the many prominent users — Sutherland Paper with 13 Unitherms and 48 Clarco Unit Heaters (suspended models for smaller area service) in its newest plant.

Exclusive Feature saves you money

Clarage's unique Syncrotherm Control maintains uniform heating with relatively low temperature air in constant circulation. By-pass dampers control the amounts of air passing through and around heating coil. Result: better use of each BTU at lower cost. Investigate this and the other features of the Unitherm Unit Heater — available for steam or hot water operation, floor or ceiling installation, in a wide size range. Write for Catalog 1115. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

CLARAGE . . . . . ***dependable equipment for making air your servant***

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

JENKINS PRACTICAL PIPING LAYOUTS 76

How to plan

PIPING CONNECTIONS FOR A GRAVITY-FEED MULTIPLE-STORY BREWERY

The piping layout illustrated is typical of installations in many breweries designed for gravity-feed processing. The following is a very brief description of some of the principal operations.

Malt drawn from the hopper is weighed, cleaned, and mixed with water in the mash tub. The required proportion of corn grits is weighed and delivered to the cooker, where it is cooked in water with enough malt added to convert and liquefy the grits. When the malt in the mash tub has been properly steeped, the finished cook is dropped into it, and the resulting mash is thoroughly mixed.

The mash is pumped into the Lauter tub, where the settled grains form a filter bed. The clear liquid containing fermentable and unfermentable sugars is drawn from the bottom, and extraction is increased by spraying the grains with hot water, called "sparging". This liquid, the "wort", flows by gravity to the brew kettle.

In the brew kettle, the wort is boiled with hops to add flavor and also to clarify and preserve it. The hops are then strained off, and the liquid is pumped into the large "coolship" tank. The spent grains are drawn off for use in by-products such as livestock feeds. After a period of settling, the wort goes through a series of coolers, where most of its heat is reclaimed in heating water for use in subsequent brewings, and passes to the starting tank.

In the starting tank, yeast is added, and the mixture then flows to the fermenters. Some of the fermenters are closed, so that the carbon dioxide gas given off can be collected and compressed for use in various processing steps. After fermentation, the beer is cooled and goes to storage tanks for eventual bottling and racking.

Jenkins Fig. 556-P and Fig. 576-P Bronze Globe Valves are recommended for bypass service in the steam lines of this layout. Plug and seat ring are a special stainless chromium-alloy steel, hardened to 500 Brinell and mirror-smooth to resist scoring and grooving. Wide, steep, 30° total taper permits extremely close regulation of flow and vapor-tight closure.

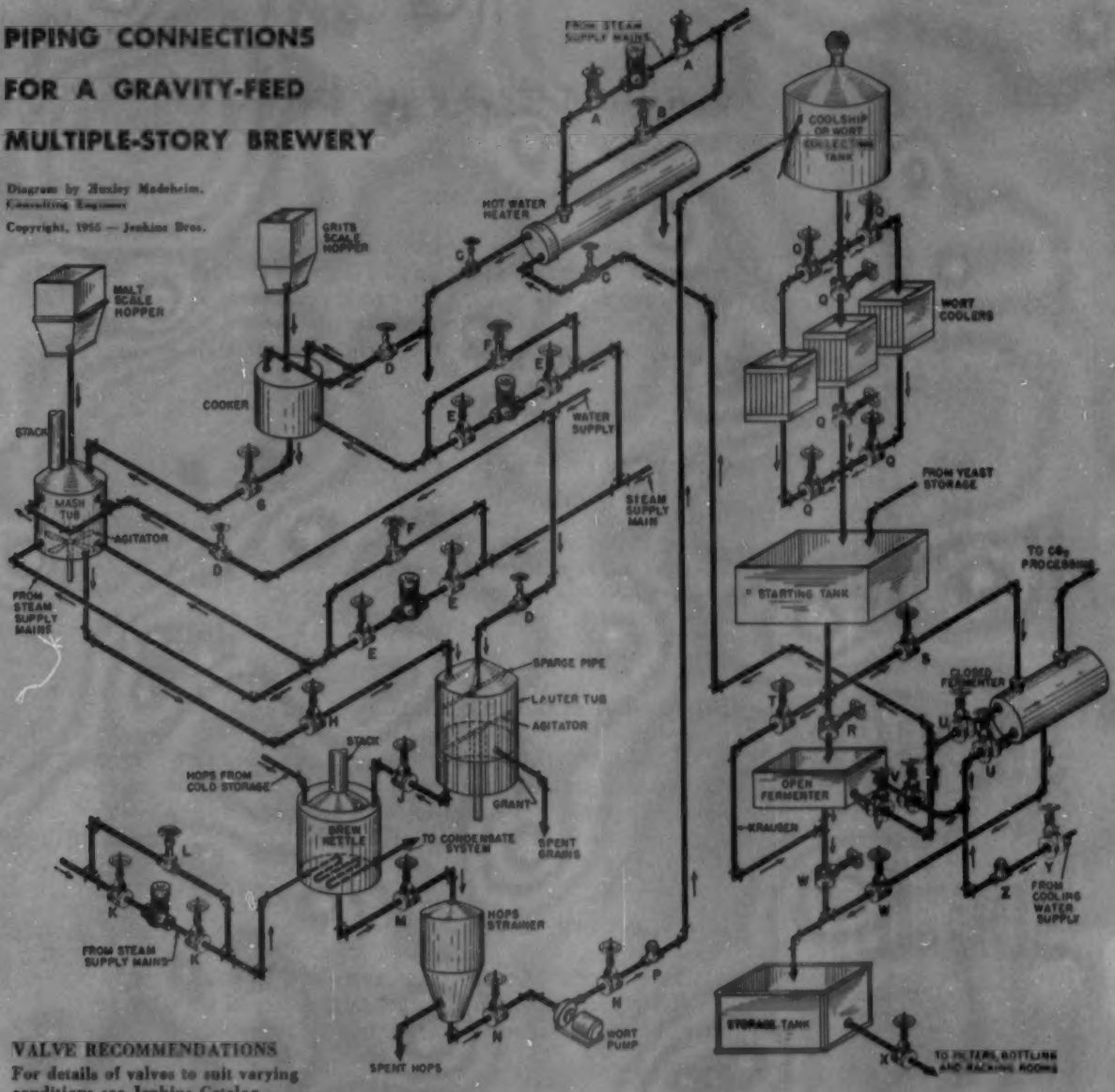
Consultation with accredited piping engineers and contractors, experienced in brewery design, is recommended when planning any phase of the various processing systems.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of *lowest cost in the long run.* Jenkins Bros., 100 Park Ave., New York 17. Sold through Plumbing-Heating and Industrial Distributors.

PIPING CONNECTIONS FOR A GRAVITY-FEED MULTIPLE-STORY BREWERY

Diagram by Huxley Madeheim, Consulting Engineer

Copyright, 1955 — Jenkins Bros.



VALVE RECOMMENDATIONS
For details of valves to suit varying conditions see Jenkins Catalog.

Code	Quan.	Jenkins Valve	Service
A	2	Fig. 275 Bronze Gate	Shutoff steam to heater
B	1	Fig. 556-P Bronze Globe	Bypass to heater
C	2	Fig. 47 Bronze Gate	Shutoff water heater
D	3	Fig. 106-A Bronze Globe	Continuous water flow
E	4	Fig. 204 I.B. Gate	Process steam shutoff
F	2	Fig. 576-P Bronze Globe	Bypass water valve
G	1	Fig. 677-A Bronze Gate	Shutoff cooker mash
H	1	Fig. 677-A Bronze Gate	Shutoff finished mash
J	1	Fig. 677-A Bronze Gate	Shutoff wort to kettle
K	2	Fig. 204 I.B. Gate	Shutoff steam to kettle
L	1	Fig. 576-P Bronze Globe	Bypass to kettle
M	1	Fig. 677-A Bronze Gate	Shutoff wort line
N	2	Fig. 677-A Bronze Gate	Pump shutoff
P	1	Fig. 352 Bronze Swing Check	Prevent backflow
Q	6	Fig. 677-A Bronze Gate	Shutoff coolers
R	1	Fig. 677-A Bronze Gate	Shutoff open fermenter
S	1	Fig. 677-A Bronze Gate	Shutoff closed fermenter
T	2	Fig. 677-A Bronze Gate	Krausen line
U	2	Fig. 675-A Bronze Gate	Water to closed fermenter

Code	Quan.	Jenkins Valve	Service
V	2	Fig. 675-A Bronze Gate	Water to open fermenter
W	2	Fig. 677-A Bronze Gate	Shutoff storage
X	1	Fig. 677-A Bronze Gate	Shutoff rack & bottling
Y	1	Fig. 675-A Bronze Gate	Shutoff well water
Z	1	Fig. 352 Bronze Swing Check	Prevent backflow

JENKINS
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Reader service section

Start with these quick samples . . .

Eating their own exhaust. . .

Is the ingenious way cat crackers generate a total of 100,000 lb of process steam per hour at two Sun Oil installations. Oxidation catalyst, known as 'Oxycat,' is what makes waste gas burn to produce cheap steam. This story, more on the first Army Package Power Reactor, news of plans for the world's biggest building, all in

Reports from the Field, p 148

Open note to busy power men. . .

Best way to keep abreast of the field is to read timely technical papers. Power editors speed this 'keeping up' job two ways by (1) selecting and digesting papers of key interest (2) showing how to get complete reports if you want them.

Technical Briefs, p 150

Fight against noise radiation. . .

within gas-distribution and steam systems gets a lift from Burgess-Manning Co's pressure-reduction silencer. Installed in downstream piping, it's claimed to cut up to 99% of the noise energy created.

Plant Equipment News, p 154

Nuclear know-how. . .

gets more important for power men every day. So you'll want item No. 50 for your catalog file. To get this, or any of the other brochures listed, use our handy post cards.

Free Literature, p 163

Had your 'work break' today?

An innovation for modern times causes a chuckle and comment by George Edwards. He's also wrapped up in such subjects as petroelectric power, balloons and injectors. . .all making good reading.

George Edwards' Scrapbook, p 166

Safety is your business. . .

Plan to attend National Safety Council's 43rd congress and exposition, Oct 17–21. Full schedule of other fall meetings listed in

Calendar of Events, p 222

For other timely ideas, see following service pages ▶

New Sarco Thermodynamic Steam Trap practically eliminates maintenance!

Only moving part—a hardened Solid Stainless Steel Disc—practically wear-proof!

SOME OF MANY ADVANTAGES

1. Same trap for all loads and pressures 10-600 psi.

2. Closes tight on no load.

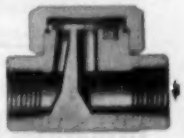
3. Operates against back pressures up to 50% of inlet pressure.

4. Not affected by superheat, water-hammer, vibration, corrosive condensate.

5. Smallest inventory of spare parts.

SIMPLICITY—to the Nth degree!

No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Three simple parts...machined from stainless steel bar stock. Only one moving part.
What could be simpler?



SARCO COMPANY, INC.

3199-B

Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

Please send me: ☐ Bulletin 255-44
☐ A Sarco Thermodynamic Steam Trap for 60-day trial. Size_____ for installation on_____

NAME_____

FIRM_____

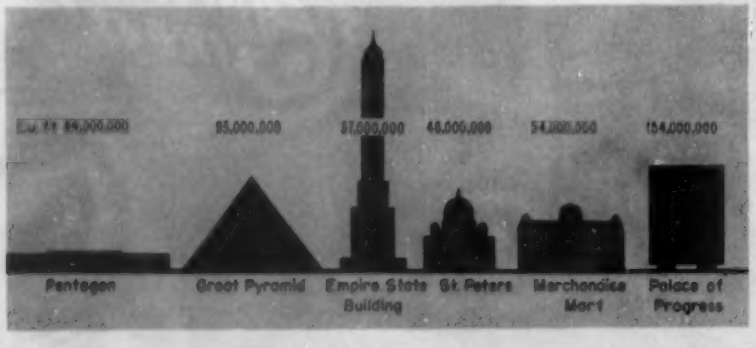
ADDRESS_____

CITY_____ STATE_____

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 222



Biggest building to have closed-circuit TV

► PLANS TO ERECT the world's largest building over a reconstructed Pennsylvania Station in New York City have been announced. Rising some 500 ft and costing more than $100-million, it will house a permanent world's fair and international merchandise mart where industrial exhibits and foreign government displays of goods and services will be set up. To be called the Palace of Progress, the building will contain 6,900,000 sq ft and 154,000,000 cu ft of space. Illustration above compares its size with other great structures.

According to William Zeckendorf, president of Webb & Knapp Inc, realty firm handling the project, there's to be a fourth dimension to the Palace known as 'videal dimension'. Every floor will be designed to serve as a television setting for closed-circuit or commercial telecasts. Lighting, acoustics and cable outlets will be engineered to permit tenants to use TV to reach the nearly 7-million sq ft of floor space and to achieve point-of-sale contact for home viewing. Where other buildings have murals and directories, the Palace will present giant-screen telecasts of activities on each floor of the building.

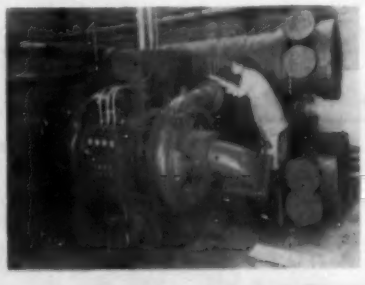
The entire terminal will be air conditioned. Moving stairways will carry pedestrian traffic to and from the street. Target date for construtcion to begin is June 1, 1956, with completion anticipated for the spring of 1958.

Stone & Webster receives nuclear power contract

► ALCO PRODUCTS, INC has named Stone & Webster Engineering Corp as engineer constructors for the first Army Package Power Reactor being built at Ft Belvoir, Va. This small power plant will employ components that can be transported by air to remote bases in any part of the world (See POWER, May 1955, p 152). A small charge of fuel will operate the plant at its full capacity for a period of 18 months.

The nuclear reactor and steam generator will be housed in a vaportight steel container 36 ft in diameter by 64 ft high. This container will be installed to prevent escape of fission products.

Heat from the reactor will be turned into steam in a steam generator. This steam will flow to a 2000-kw turbine generator located in an adjacent powerhouse. Circulating water for the condenser will be taken from the Potomac River. Electricity generated here will be used at the Ft Belvoir installation.



Cracking plants feed on own exhaust gases

► TWO CATALYTIC petroleum cracking plants that feed on their own exhaust gases in order to supply steam needed for their operation have been placed on stream by the Sun Oil Company.

The cat crackers—one each at Sun's Toledo, Ohio and Marcus Hook, Pa. refineries—make use of special catalytic waste-heat boilers to burn their own flue gases before they reach the air. In so doing they generate 100,000 lb of process steam per hr. Used for the process is the oxidation catalyst known as *Oxycat* and manufactured by Oxy-Catalyst, Inc.

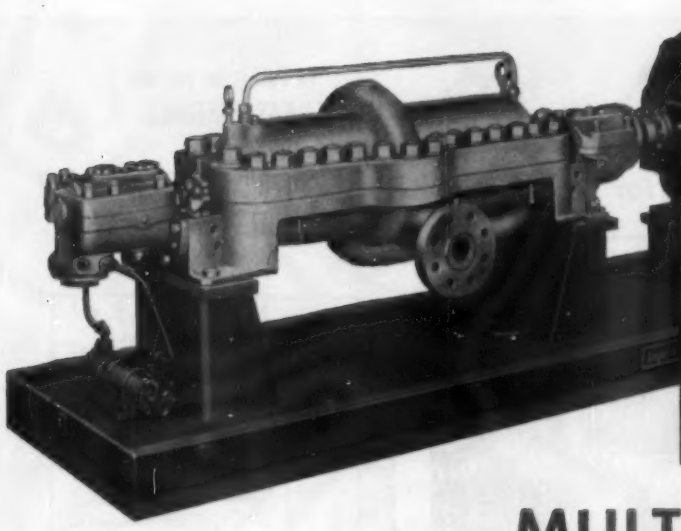
Each *Oxycat*—there are more than 20,000 of them installed in the catalytic waste-heat boilers at the two plants—is a brick-size structure consisting of 71 slender porcelain rods suspended between two square porcelain endplates. A thin catalytic coating on the *Oxycat* rods oxidizes the carbon monoxide and hydrocarbon oil vapors in the cat cracker exhaust to a clean effluent

(*Continued on page* 220)

World's largest hermetic motor powers 600-hp compressor

► THE WORLD'S LARGEST hermetically-sealed electric motor is being used to drive a 600-hp centrifugal refrigeration compressor. The squirrel-cage unit is completely sealed within the casing of the two-stage compressor.

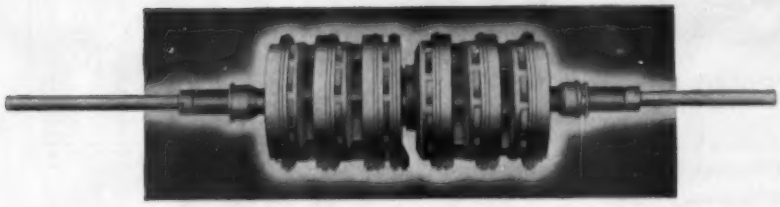
Having a refrigeration capacity of 800 tons, or twice that of previous units, this packaged set is designed mainly to supply economical chilled water for industrial process applications and for air-conditioning systems in large buildings and industrial plants.



Ingersoll-Rand

CNTA

MULTI-STAGE PUMPS



extend the advantages of the

UNIT-TYPE ROTOR ASSEMBLY

HIGHER SUSTAINED EFFICIENCY

Greater simplicity of design, with precision-matched impellers and channel rings, permits unusually high efficiency which is sustained throughout years of operation.

GREATER DEPENDABILITY

Radial balance with multiple-volute design and axial balance with opposed impeller grouping, assure long trouble-free operation. The smooth-bore, symmetrical outer casing eliminates any possibility of distortion under high temperature operation.

REDUCED MAINTENANCE

Entire rotor assembly can be removed from the casing as a single, compact unit, without disturbing piping connections. There are no ring fits to align on replacement of the rotor assembly.

to your medium pressure applications

• With the completely re-designed line of CNTA multi-stage pumps, Ingersoll-Rand offers a new high in performance, efficiency, dependability and economy—for medium-pressure boiler feed, mine dewatering, marine, petro-chemical and general hydraulic services.

The advanced design Unit-Type rotor assembly, with impellers and channel rings mounted on a single, heavy-duty shaft and with a smooth-bore outer casing, is the same type as that used by Ingersoll-Rand in the high-pressure CHTA and HMTA lines. The result of this modern construction is a dependable, simpler and more rugged unit that requires minimum attention and maintenance.

CNTA pumps are multi-stage, horizontally split units, with single-suction impeller groups placed back-to-back to eliminate hydraulic thrust. They are available in 4, 6 and 8 stages for pressures from 100 to 800 psi, in capacities from 50 to 700 gpm.

Your I-R representative will be glad to give you the *complete story.*

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11 Broadway, New York 4, N. Y.

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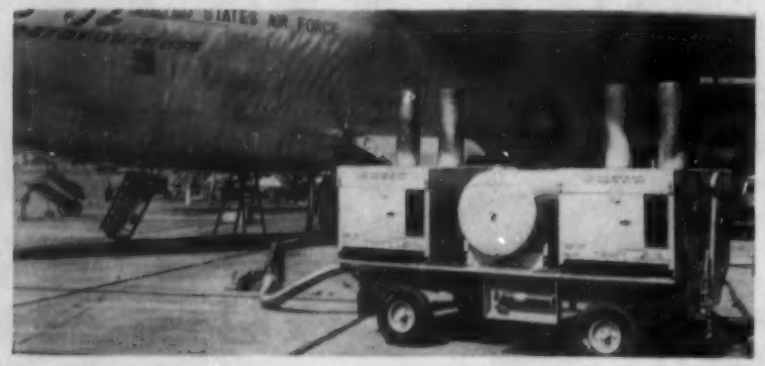
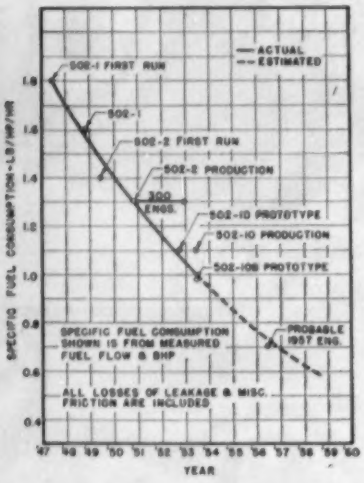


1 Two-stage centrifugal compressor is gas-turbine driven, supplies compressed air for plane starting, servicing



2 Continuous study and development have reduced the fuel consumption of small gas turbines, see curve at right

Research promises bright future for small portable gas turbines

Progress in Boeing's small gas turbines. *By W B Anderson, Boeing Airplane Co.*

When and where small gas turbines will come into general use is a highly controversial subject. It is under continuous consideration by companies investing large sums in its development. Despite considerable development work, use of small gas turbines is presently limited to certain special military applications where requirements cannot be met by conventional piston engines.

Since 1947 the continuous-rating horsepower of the Boeing unit has risen from 100 to 240 hp, in practically the same package. A newer engine is expected to produce 400 hp on continuous operation, 450 hp for emergency use.

Fig. 2, above right, shows the improvement in specific fuel consumption during the past eight years. Consumption dropped from 1.8 lb per hp hr in 1947 to 1.0 lb per hp hr in the present production engine. Curve is extrapolated to show the improvement expected from current research programs. At 0.7 lb per hp hr, the advantages of the future engine are expected to make it competitive with diesel and gasoline engines.

An established use of the small gas turbine is supplying low-pressure compressed air for starting and ground servicing the newer jet airplanes, Fig. 1, above left. At present this is Boeing's major production effort. The free-shaft torque-converter characteristic has proved advantageous in this application by giving maximum air horsepower over a broad range of requirements and by simplifying control. *APC paper; no number.*

The evaluation of corrosion resistance for gas-turbine blade materials. *By W E Young, A E Hershey and C E Hussey Jr, Westinghouse Electric Corp.*

Surface analysis of gas-turbine blade material before and after exposure to the combustion products of residual fuel oils, demonstrates the corrosive effect of these products. A measurable indication may be obtained in a fraction of the testing time required to produce appreciable weight loss.

Surface analysis has the further advantage that it is possible to measure corrosion in specific regions on a specimen where exposed to a gas-flow pattern with a well-defined temperature profile.

Weight-loss measurements following long-time tests show good agreement with this method of analysis. Fusion temperature of the fuel ash appears to be a reliable criterion for judging the potential corrosivity of residual fuel oil. Good correlation has been obtained between ash-fusion temperatures and corrosion both for untreated oils and oils with additives. *ASME paper no. 54-A-215.*

Experimental cooling of radial-flow turbines. *By E N Petrick, Curtiss Wright Corp and R D Smith, Purdue University.*

An air-cooled radial-flow gas turbine having a 12-in. diameter aluminum rotor was operated with inlet gas temperatures of 960 R to 1060 R. Cooling air was at ambient temperature and flowed over the back face of the turbine rotor. Temperature, measured at 11 positions on the rotor surface, gave an indication of the effectiveness of the cooling.

Equations are presented for computation of the surface coefficients of heat transfer from the rotating disk to a forced convective turbulent flow of air for several different cases.

Experimental results were correlated by defining a modified Reynolds num-

Painting, courtesy Power Magazine

New J-M Color Code

identifies metal in Spirotallic® Gaskets

Most engineers know that Spirotallic Gaskets maintain a perfect seal despite extreme fluctuation in fluid pressure and flange compression. Consequently, these gaskets are used in a wide range of service conditions which include high temperatures, elevated pressures and active corrosives. To withstand these conditions, Spirotallic Gaskets employ a variety of corrosion-resistant alloys.

Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-35A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications

Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

Copper—brown

Aluminum—aluminum

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Johns-Manville SPIROTALLIC GASKETS

More TECHNICAL BRIEFS

Begins on page 150

ber, and by including an area parameter analogous to the length-over-diameter ratio frequently employed for correlating heat-transfer results in pipe flow. *ASME paper no. 54-A-245.*

The influence of some chemical and physical factors on the formation of deposits from residual fuels. *By P T Sulzer, Sulzer Bros, Ltd.*

The oil-ash deposit problem in industrial gas-turbine plants is analyzed in this paper from both physical and chemical standpoints. Theory and experiments on the formation of ash during combustion enable important processes in the build-up of deposits to be understood. Measurements of ash-deposit formation as a function of temperature, pressure, excess air, fuel-ash content and test duration, are shown graphically and summarized in a formula. *ASME paper no. 54-A-171.*

Other papers of timely interest:

A 5000-kw railway-mounted gas-turbine power plant. *By C H Giroux, Office, Chief of Engineers, J O Stephens and R J Nolte, Westinghouse Electric Corp. ASME paper no. 54-A-191.*

Flame-stabilized oxy-fuel gas burners. *By W B Moen and T L Shepherd, Air Reduction Co, Inc. ASME paper no. 54-A-193.*

A method of aerothermodynamic design of multi-stage reaction turbines. *By S L Soo, Princeton University. ASME paper no. 54-A-208.*

Gas-turbine bucket-operating experience and bucket and wheel design method. *By T N Hull, Jr, General Electric Co. ASME paper no. 54-A-172.*

Hydro

The ultrasonic measurement of hydraulic turbine discharge. *By R C Swengel, Consultant, W B Hess, Safe Harbor Water Power Corp, and S K Waldorf, Pennsylvania Water & Power Company.*

To obtain basic discharge data necessary for efficient hydro-electric operation, a new ultrasonic flowmeter has been developed and applied to flow measurement in large water passages. During the development period, extensive tests under varied conditions of flow were made in a 5x9-in. passage using a weighing tank as the absolute standard. Accuracies of 1% or less were achieved regularly with appreciably turbulent and non-uniform flow distributions, using river water of varying turbidity. Installation in a 16x25-ft turbine intake has demonstrated the practicality of the method and equipment. *ASME paper no. 54-A-54.*

Directions for ordering papers on p 212

APC PAPERS AVAILABLE

Clothbound copies of the "Proceedings" of the 1955 American Power Conference, containing the papers presented at the conference, are now available at $6.00 per copy. Copies may be obtained from Dr R A Budenholzer, Director, American Power Conference, Technology Center, Chicago 16, Illinois.

An experimental and analytical investigation of a differential surge tank installation. *By W L Gibson and W Shelson, Hydro-Electric Power Commission of Ontario.*

Performance of a differential surge tank was measured experimentally for various acceleration and retardation conditions. Results were compared with those obtained analytically. In the experimental investigation, dynamic pressures at several places in the hydraulic system, together with turbine gate positions, were recorded simultaneously on a multichannel oscillograph.

For comparison, corresponding water-hammer pressures and mass flows in the system were calculated by recognized step-by-step processes, adequate numbers of steps being made practicable by use of high-speed digital computers. Calculated results agreed closely with those determined experimentally. *ASME paper no. 54-A-138.*

Co-ordination of hydro and steam generation. *By C W Watchorn, Pennsylvania Water and Power Co.*

So far as determined there is little of a fundamental nature available in literature with respect to the basis for coordinating hydro and steam generation for maximum over-all operating economy. This appears to be so even though fundamentals of coordinating operation of hydro units within a plant were first set forth in 1919, and shortly thereafter, in 1922, with respect to steam units. Coordination of steam generation and incremental transmission losses has been treated quite thoroughly more recently.

Basically, coordination of hydro and steam generation for maximum over-all economy, especially when tailrace losses and possible use of pondage are considerations, is much more involved than that for any of the above. Under such circumstances, operation at any time during a period of pondage affects the results for the whole of that period of pondage operation. But for steam, operation from instant to instant is largely independent of any other instant. Such facts are of particular importance with respect to seasonal pondage operation, and with respect to daily or weekly pondage operation for which comparatively large amounts of water are involved.

It is frequently thought that when a limited amount of hydro energy is available, the most advantageous or desirable operation is to utilize the energy in the load peak to as great an extent as possible since this results in the smallest amounts of required higher cost steam generation. Losses resulting from the increase in the amount of lower cost generation outweigh savings resulting from reduction in amount of higher cost steam generation required. Optimum operation is a compromise between operation that results in the maximum amount of hydro generation on one hand, and operation that results in hydro generation that replaces the maximum possible amount of the otherwise higher cost steam generation. *AIEE paper no. 55-33.*

Other papers of timely interest:

Momentum and mass transfer in a submerged water jet. *By Walton Forstall and E W Gaylord, Carnegie Institute of Technology. ASME paper no. 54-A-38.*

Stability of umbrella-type vertical waterwheel generators. *By John J Hart, Westinghouse Electric Corp. ASME paper no. 54-A-148.*

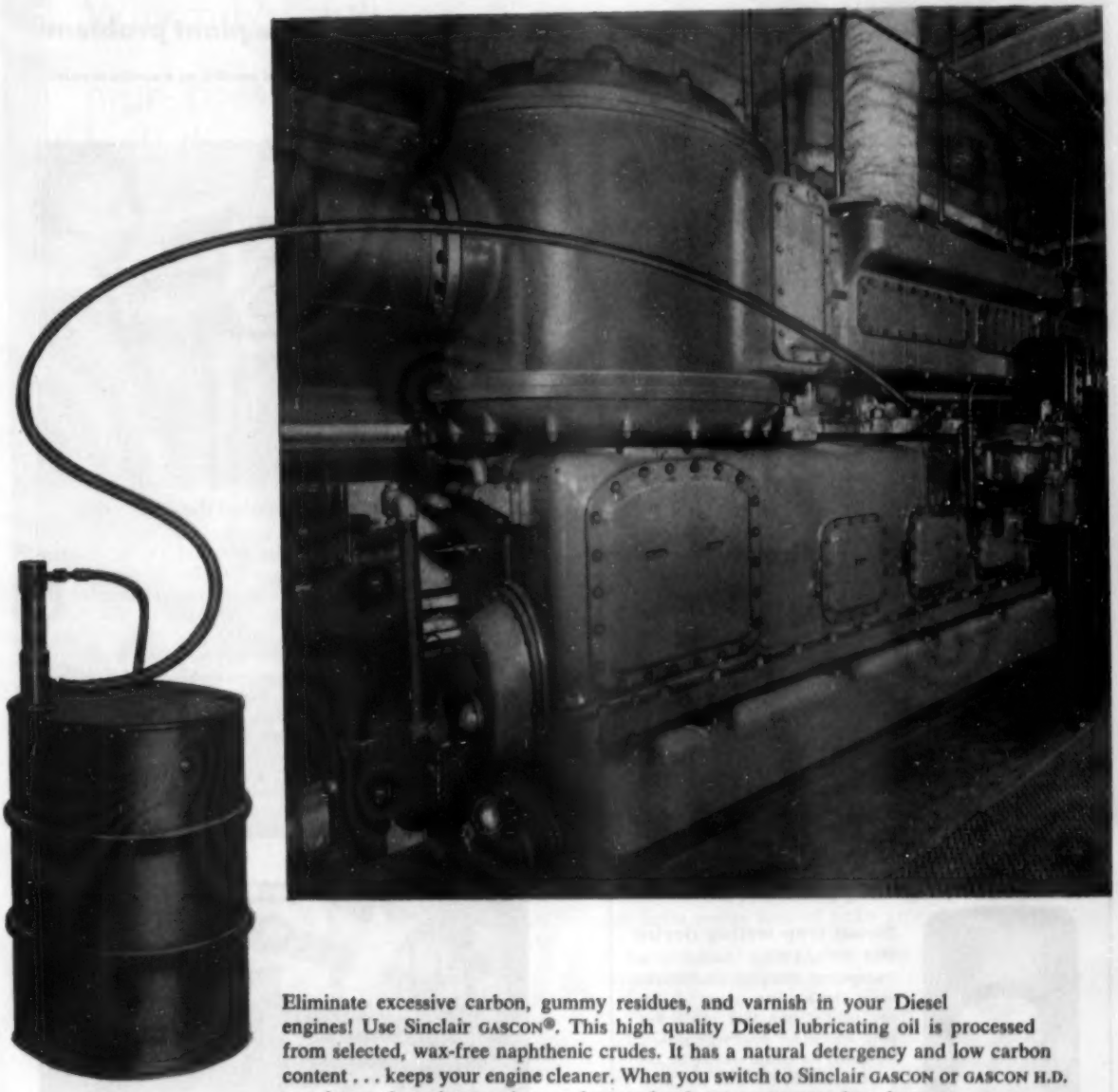
Fluid flow

Through flow in concentric and eccentric annuli of fine clearance with and without relative motion of the boundaries. *By L N Tao and W Donovan, Worthington Corporation.*

Problem of the through flow across annuli of fine clearance has been investigated both theoretically and experimentally and is reported in this paper. The study includes effects due to rela-

(*Continued on page* 208)

Check Carbon!



Eliminate excessive carbon, gummy residues, and varnish in your Diesel engines! Use Sinclair GASCON®. This high quality Diesel lubricating oil is processed from selected, wax-free naphthenic crudes. It has a natural detergency and low carbon content . . . keeps your engine cleaner. When you switch to Sinclair GASCON or GASCON H.D. you know that pistons, rings, valves and exhaust ports stay free from carbon, gums and varnish.

No matter what design of engine you're operating, you'll be 'way ahead with Sinclair's complete line of Diesel lubricants. Contact your local Sinclair Representative now for full details, or write Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N.Y.

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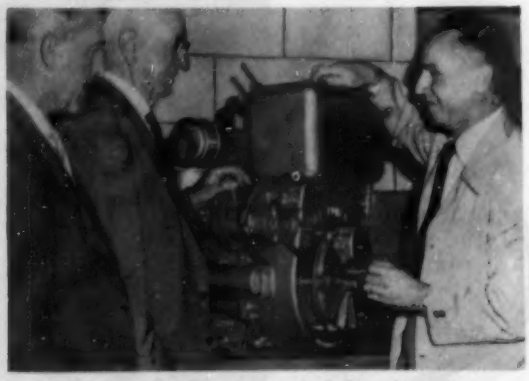
Centrally-located air-conditioning units

901 • Three basic cabinet-type units are included in the line: (1) air-conditioning units (2) sprayed-coil conditioners (3) multi-zone conditioners, shown above. Claimed features include compactness, simple installation, design flexibility and a capacity range in all types from 600 to 46,000 cfm.

Air-conditioning and sprayed-coil units are available as either horizontal or vertical arrangements, both with horizontal air flow through the cooling units. Multi-zone conditioners are in one arrangement for either horizontal or vertical air flow. Cooling and dehumidifying can be done with chilled water, direct-expanded refrigerant or brines. Heating is accomplished with steam or hot water. Full details on request.

American Blower Corporation, Detroit 32, Michigan



Single-cylinder air-cooled diesel engine

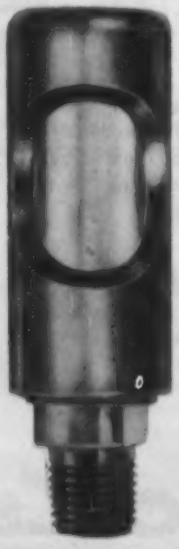
902 • Unit is described as the first practical, small air-cooled diesel engine. It has a bore and stroke of 3¾ in., develops eight hp at 1800 rpm and weighs 235 lbs. In test, the unit has been clocked over 4000 hrs of continuous operation and according to manufacturer's plans will run until it fails—expected to be after more than 10,000 hrs.

A claimed feature is its capacity to burn all of the injected fuel, whereas most diesels have a "leak off" at the fuel injectors to drain and return excess fuel to the main fuel supply.

This diesel is expected to find industrial use for driving water pumps, electric generators and air compressors. Displacement is 41 cu in., compression ratio 17:1.

Diesel Power Inc, Box 72, Greenville, Pennsylvania

For more data on these items, use post cards p 163. Identify your request with item number.

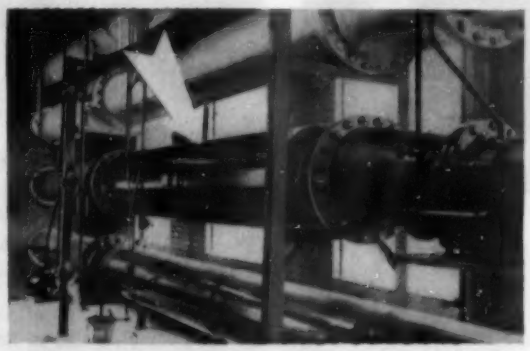


Steam trap testing device

903 • *Vis-A-Plug* device is a transparent test plug used to visually check steam traps. It fits any bucket trap that has a test plug above the discharge orifice. Designed for steam service of 250 psi and 400 F, the unit has been tested hydraulically for 500 psi. The device is recommended for use in testing traps handling clean condensate, traps draining critical process equipment and for trap maintenance programs.

This item previously appeared in August POWER, p 170. Specification changes have since been made and are correctly noted in above copy. The R&R Company, previously listed as the manufacturer, has been replaced by

Vis-A-Plug Inc, Box 100, King of Prussia, Pa.



Silencer for pressure-reduction operations

904 • Pipe ring and resultant noise radiation within gas distribution and steam systems can be effectively eliminated by this pressure-reduction silencer. Manufacturer claims unit removes 95 to 99% of noise energy created by pressure-reduction operations. Installed in the downstream piping, in close proximity to the reduction valve, unit stops noise at its source.

Design and construction is in accordance with the applicable code for piping and pressure vessels. Unit does not restrict flow of gas or steam in the line. Full details on request.

Burgess-Manning Co, 749 E Park Ave, Libertyville, Ill.

Why buy small

high pressure valsve that lack these CRANE features?

New 1500 and 2500 pound check patterns . . . screwed or socket welding ends; ½" to 2". Patented construction assures high disc lift, free flow and minimum pressure drop.

1500 and 2500 pound globe patterns... screwed or socket welding ends; ½" to 2".

1500 and 2500 pound angle patterns... screwed or socket welding ends; ½" to 2".

When you buy CRANE Lip-Seal Bonnet Valves . . . designed exclusively for high pressure/high temperature power plant service . . . you are assured of:

- lip-seal welds that are laid on flat surfaces—needn't be chipped out or burned out;
- easy dismantling and reassembly—bonnet screws out after weld is *ground away*—makes inside of valves entirely accessible;
- bonnet threads are chrome plated to prevent galling or seizing;
- stems that do not bind or gall—because of CRANE's exclusive ball-joint glands;
- easy access to stuffing box—swing-type gland eye-bolts swing free of yoke area, can't be lost;
- a more rigid swivel disc-stem connection that minimizes vibration;
- each size valve is a separate design for proper proportion—another CRANE exclusive.

Specify "Crane Lip-Seal" when you want small valves for high pressure/high temperature steam service. For more reasons why you should do so, ask your CRANE representative for Circular AD1902, or write direct. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

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More EQUIPMENT NEWS

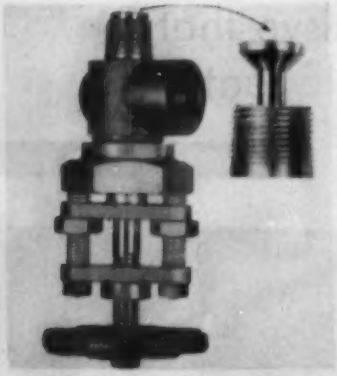
Begins on page 154

Looking for the right valve? Check these recent developments

Materials handling valves

905 • These valves, intended for installation in vacuum transport piping systems, are available with either air-electric, remote or manual controls. They are designed for handling materials such as boiler flyash and other industrial dusts. Self-feeding feature of *Type C* valves is said to eliminate plugging. Atmospheric air, admitted into vacuum system through inlet ports, continuously picks up and sweeps material through valve into transport piping at rates automatically matched to increases and decreases of the system load.

The Allen-Sherman-Hoff Co, 259 E Lancaster Ave, Wynnewood, Pa.

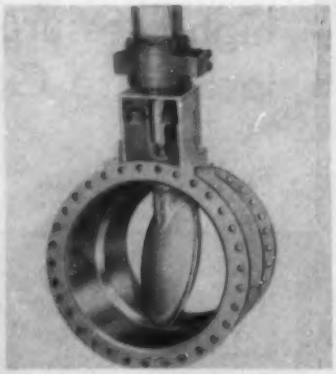


Drain or sampling valve

906 • Manufacturer states that unit is completely self-draining for the valve stem seats on outside of valve body. It is recommended for installations where it is desirable to have valve seat inside the wall of a vessel to prevent liquid from remaining in the nipple and valve.

The *No. 23* valve has outside screw and yoke construction to meet high temperature or corrosive conditions. This is said to eliminate possible freezing and allow valve stem to work freely. Recommended for use with pressures to 4000 lbs at 100 F or 1000 lbs at 750 F.

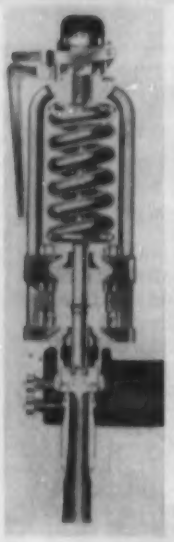
Jerguson Gage & Valve Co, 80 Fellsway, Somerville 45, Mass.



Sealed butterfly valve

907 • Stress-sealed butterfly valve is designed to meet the rigorous tolerance of permissible leakage in the closed position under high pressure and high temperature. It is 36-in. pipe size, fabricated of mild steel, with 125-lb American Standard flanges. The steel disk has a stainless-steel seating edge. When disk is rotated to closed position it seats against an Inconel-X band in the valve body. This band is then inflated under nitrogen pressure for essentially tight shutoff at operating temperatures to 800 F. Full data available on request.

W S Rockwell Co, 200 Eliot St, Fairfield, Connecticut



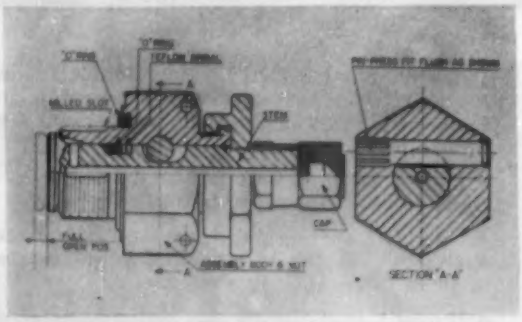
High-capacity safety valve for pressures to 3000 lbs

908 • These valves are designed for pressures ranging to 3000 lbs and for temperatures to 1050 F. They are available with flanged outlet and either welded or flanged inlet. Sizes range from 2 to 4 in.

For superheater service a cooling spool and spindle having a high thermal expansion coefficient are used to provide proportional thermal compensation.

Relieving capacity is ASME certified. Two adjusting rings provide control over the reactive and expansive forces of the flowing steam to produce full disk-lift. This allows valve capacity to be governed by noxzle throat area alone. These adjusting rings provide predictable blowdown control. Request catalog 400-HC from the manufacturer.

Crosby Steam Gage & Valve Co, Wrentham, Massachusetts



Gas-charging valve has unique safety factors

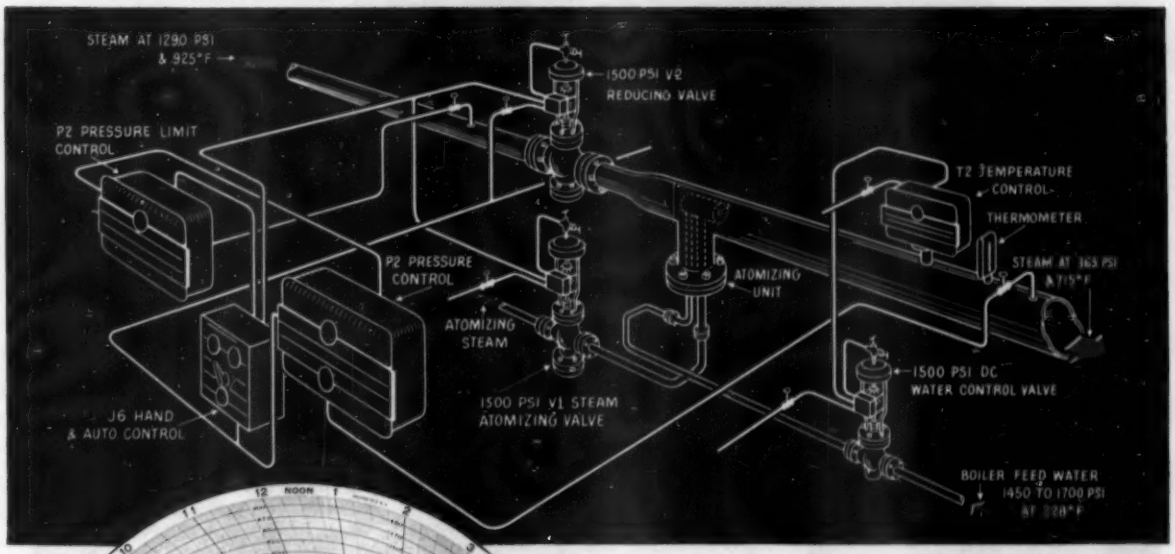
909 • Specifically designed for the Army, Navy and Air Force, this valve is now available for industrial applications. It is interchangeable with any previous A-N valve being used to charge hydraulic and pneumatic systems with gas. The unit is designed for 5000 psi working pressure and 20,000 psi burst pressure.

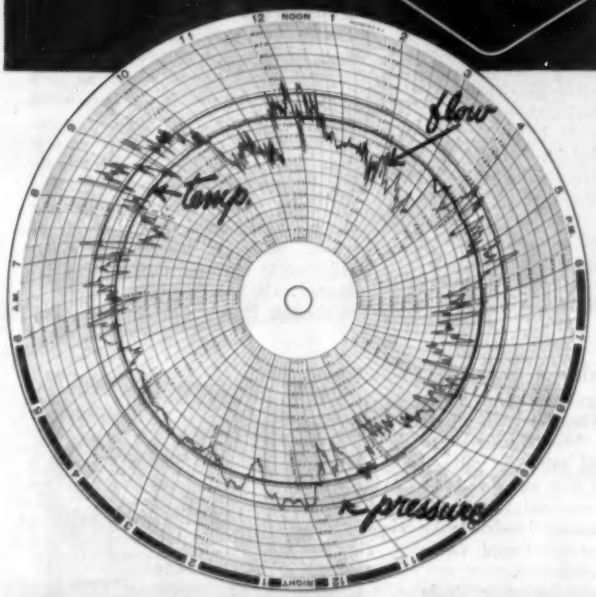
Prime safety factor is the pin built into the locking head. This prevents stem from dropping into the body of the gas cylinder. An adjustable stem that works as an ice crusher eliminates ice formation around the gas inlet ports caused by the accelerated and expanding charging gas. Request details.

Superior Pipe Specialties Co, Superior Hydraulics Division, 15201 St Clair Ave, Cleveland 10, Ohio

To obtain more information on these new equipment items, use post cards on page 163. Identify your request with item number.

Swartwout RDC* controls within ±1 psi and ±3°F even with widely fluctuating load swings

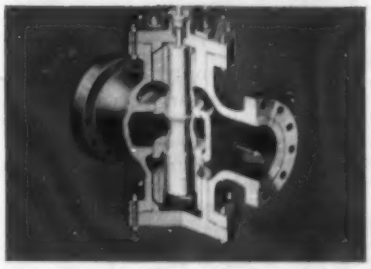

STEAM AT 1290 PSI & 925°F
1500 PSI V2 REDUCING VALVE
P2 PRESSURE LIMIT CONTROL
T2 TEMPERATURE CONTROL
THERMOMETER
P2 PRESSURE CONTROL
ATOMIZING UNIT
STEAM AT 365 PSI & 715°F
ATOMIZING STEAM
1500 PSI DC WATER CONTROL VALVE
1500 PSI V1 STEAM ATOMIZING VALVE
J6 HAND & AUTO CONTROL
BOILER FEED WATER 1450 TO 1700 PSI AT 328°F



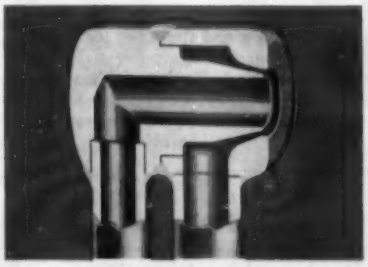
1 Chart shows how Swartwout RDC* — Reducing, Desuperheating and Control System — handles low-pressure turbine load of 65,000 to 165,000 lbs. steam per hour in a large midwestern utility. It reduces from 1290 to 365 psi and desuperheats from 925° to 715° F. When main reducing valve closes, extremely light loads can be handled by pressure reducing valve supplying atomizing steam. Operation of the system is stable regardless of load change or time lag. Because of the exceptional control obtained by this large station, the company later purchased an additional small Swartwout reducing, desuperheating and control unit to supply steam to house turbines.

Swartwout

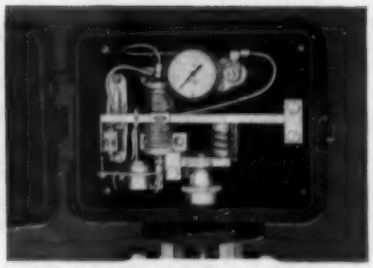
POWER PLANT EQUIPMENT
PROCESS INDUSTRY CONTROLS
INDUSTRIAL VENTILATION



2 Swartwout V2DD Regulating Valve has smooth, nozzle-shaped passages which guide expansion of high-pressure steam to reduced pressure zone without high-velocity impingement or other destructive forces common to conventional valves. Undue noise, turbulence, vibration are eliminated; longer life results.



3 Swartwout Steam Atomizing Desuperheater, constructed of stainless steel, has accurately machined passages that give narrow-angle dispersion of cooling water outside of steam atomizing head. There is no impingement of steam or water against walls of unit, no erosion of parts, no need for pipe liners.



4 Swartwout T-2 Control, with metallic temperature element in steam pipe, gives rapid and precise control regardless of magnitude of load or time lag. There are no flapper valves, relays or other delicate elements. Only two simple adjustments are involved; one for temperature, one for response.

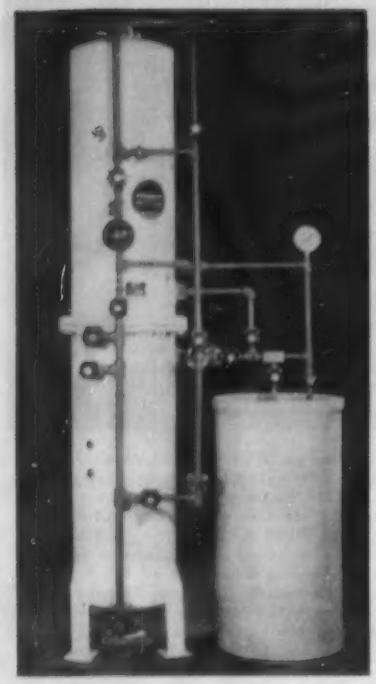
AA-1800

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

More EQUIPMENT NEWS

Begins on page 154

Products designed to help solve water-treatment problems



Mixed-bed demineralizer

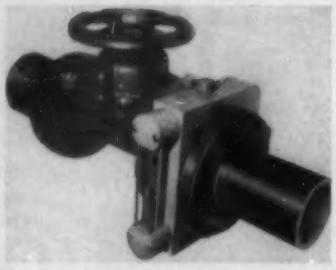
914 • Unit is designed for demineralization of relatively small quantities of water —up to 360 gph. The device contains a resin bed consisting of an intimate mixture of cation exchanger and strongly basic anion exchanger. It will produce a water of low total dissolved solids, low CO_2, low silica content and low conductivity.

Manufacturer claims that treated effluent from this unit will have an average conductivity of 0.15 micromhos which is equivalent to approximately 6,000,000 ohms-cm specific resistance or 0.05 ppm total electrolyte content. Also, CO_2 will be reduced to 0-1 ppm and the silica to about 0.1 ppm.

Flow rate is 6 gpm average to 7.5 gpm maximum. The device has a kilograin capacity of 24,000 grains total dissolved solids and is capable of treating 4100 gallons of raw water containing 100 ppm total electrolytes. The mixed-bed tank contains 5.4 cu ft of resin and is 15-in. in diameter and 7 ft 7 in. in over-all height.

When unit is exhausted, the resin bed is regenerated with 12 lbs of sulfuric acid for the cation exchanger and 20 lbs of caustic soda for the anion exchanger. Full information on request to manufacturer.

The Permutit Co, 330 W 42nd St, New York 36, New York



Chlorine flow indicator

918 • Indicator is designed for measuring flows of chlorine solution through lines from two to six inches in diameter. It withstands working pressures to 100 psig. In operation unit is mounted directly in pipe line which must be horizontal. Metering tube is always mounted vertically. Most of main line flow passes through orifice but a small proportion flows through by-pass line in the housing, up through glass metering tube and down another channel in housing to an opening on downstream side of orifice. Scale reading opposite glass-ball float in metering tube directly indicates main line flow rate.

Fischer & Porter Co, Hatboro, Pa.

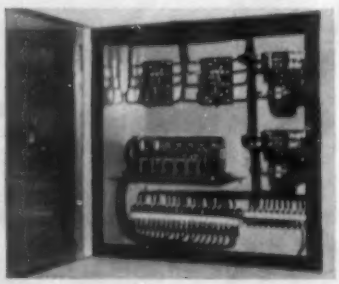
Zeolite softeners supply water of zero hardness

915 • These units eliminate the hardness of water (sodium and magnesium compounds) for use as boiler feedwater in laundries, textile plants and other industrial applications.

Using the ion-exchange principle with salt-brine regeneration, these softeners can supply water of zero hardness. Various zeolites, including greensand, synthetic gel and styrene resins, can be used—selection depending on nature of the raw water and the flow rate required. A patented single-control valve eliminates conventional valve nests usually required for regeneration. Manufacturer claims this pilot-actuated valve to be fool-proof in operation since it is impossible for internal diaphgram-actuated valves to be in any position other than that required by the desired operating step.

Two basic types of regenerating equipment are available. A combination or single salt dissolving and measuring tank is adequate for most small plants on manual control. For larger installations, a two tank system, one for dissolving and the other for measuring, provides greater salt storage and requires less attention. A water meter on softener outlet indicates total amount of water treated and provides an indication of when regeneration must be initiated. Full details in bulletin 4520-B.

Cochrane Corporation, 3107 N 17th St, Philadelphia 32, Pennsylvania



Softener control system

917 • System is part of a pre-engineered unit that includes electrical control panel, flowmeter, automatic multi-port valve, zeolite softeners, brine-measuring tanks and connecting lines. Outstanding feature is electrical control panel containing a series of relays and a multiple-cam timer that initiate periodic regeneration of the softeners.

Incoming raw water is measured by an inlet water-meter register. When a predetermined volume of water has passed through the meter a contact closes, beginning the regeneration.

Graver Water Conditioning Co, 216 W 14th St, New York, N. Y.

Synthetic polymers speed settling and filtration

916 • To speed settling and filtration, *Aerofloc* reagents agglomerate finely-divided particles in suspensions. Developed originally for the mining industry, this group of synthetic polymers should find use in water and waste treatment where agglomeration of colloidal material and organic slimes increase effective capacity of filters.

Aerofloc reagents are large, complex molecules which, when added to aqueous suspensions, bond together the individual fine solid particles into flocs. These flocs settle more rapidly than unconsolidated particles, leaving clarified fluid suitable for re-use or for discarding without creating a pollution problem.

American Cyanamid Co, 30 Rockefeller Plaza, New York 20, New York

For more data on these items, use post cards p 163. Identify your request with item number.

G-E Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-amperes, 600 Volts, A-C. One pole shown. Made by General Electric Company, Low Voltage Switchgear Department, 6901 Elmwood Ave., Philadelphia, Pa.

Here is the General Electric Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-ampere frame size used to protect low-voltage systems. The picture shows one pole of the contact, and in order to photograph it, the housing and the arc-quencher parts were removed. Note the Revere Extruded Shapes, and Rectangular Rod. There are three shapes, and one size of bar, all in copper, because copper has the highest electrical conductivity of all commercial metals.

If these shapes had to be "hogged" out of bar, they would be expensive, due to the machining time, and the scrap generated. While copper scrap is readily salable at good prices, it is costly from the machining standpoint. Extruded shapes by Revere, preformed to the desired contours, usually reduce machining to a cutting-off operation, plus such minor details as drilling which cannot be done during extrusion. Shapes naturally cost more per pound than bar or rod, but the ultimate saving makes up for the difference and more, sometimes several times.

Are you doing much machining of copper? If so, look into Revere Extruded Shapes. They may save money, and speed up production as well. See the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

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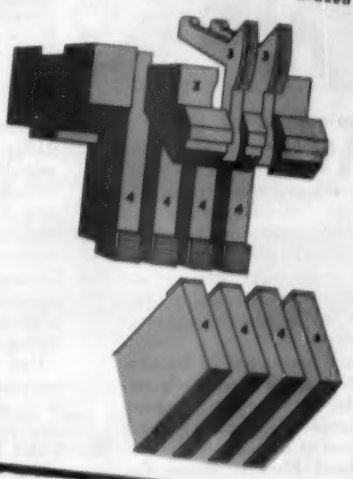
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. —Sales Offices in Principal Cities, Distributors Everywhere

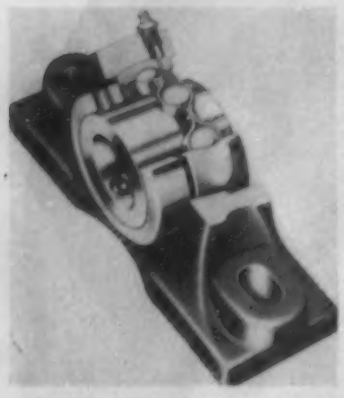
Sketch showing details of contacts. Nos. 1, 2 and 3 are extruded and drawn copper shapes. No. 4 is rectangular copper bar. Cross hatching represents special arcing contacts brazed to the copper.



More EQUIPMENT NEWS

Begins on page 154

Mechanical transmission equipment



Medium-duty ball bearings

910 • Designed for medium-duty service, these *SCM* ball bearings provide more load-carrying capacity and are available in larger shaft sizes than manufacturer's *SC* line. The new series includes both ball-bearing pillow blocks and ball-bearing flange cartridge mounts.

Full self-alignment is provided by the spherical outer race of the ball-bearing inner unit, which fits into the spherical seat in the semi-steel housing. Metallic-backed synthetic seals are mechanically anchored in position—won't blow under grease-gun pressure. Request bulletin A-638 from the manufacturer.

Dodge Manufacturing Corp, Mishawaka, Indiana

Variable-speed pulley

911 • This ¾-hp unit is readily adapted to new or old equipment. The spring cover has been eliminated since the pulley is usually used in the enclosed portion of the machinery. Simplicity of design has cut initial costs and reduced upkeep and maintenance, manufacturer states.

Pulley delivers a speed ratio to 2¾ to 1, using an *A* section belt. Maximum bore is ⅞ in. with keyway. Shaft bore runs through the entire length of the pulley giving the advantage of reverse mounting. Over-all unit length is 4 13/16 in.; diameter is 6 in.; weight 6½ lbs.

Lovejoy Flexible Coupling Co, 4870 W Lake St, Chicago, Ill.

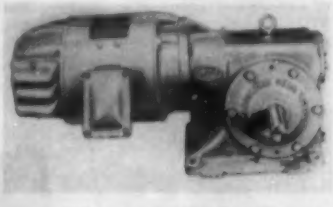
Mechanical motor brake

912 • Unit is built into motor frame and enclosed in housing. It is claimed to save as much as 7⅞ in. in length as compared to conventional electric brakes. Being mechanical in action, solenoids and coils are eliminated.

Unit allows for quick opening and avoids sudden impact on stopping. Tension springs can be adjusted for rapid or slower stops.

These motor brakes can be installed in any position and are especially recommended for work requiring frequent braking. Complete information available on request to manufacturer.

The Cleveland Electric Motor Co, Dept MB, 5213 Chester Avenue, Cleveland 3, Ohio



Worm-gear reducer

913 • Motorized right-angle unit is available in sizes from 1 to 50 hp with reduction ratios from 3⅝ to 1, to 90 to 1. Gearings and bearings have been oversized for maximum strength. An important feature, according to manufacturer, is that a flexible coupling connecting motor shaft and worm shaft is enclosed within the gear unit, eliminating alignment problems.

Unit may be mounted along side of equipment rather than in aisles because of its compact size. For complete ratings and dimensions request catalog WG-A from the manufacturer.

Philadelphia Gear Works, Inc, Erie Avenue and G Street, Philadelphia 34, Pennsylvania

Condensation return units

919 • Units are designed for use with heating systems having ratings from 800 to 10,000 edr and pressures to 80 psi. They are offered in both simplex (single pump) and duplex (twin pump) models. The latter are used to return condensate to two boilers or, when connected to a single boiler, to provide built-in standby facilities.

Pump and motor assembly is close-coupled, designed without shaft bearings, and mounted on resilient synthetic rubber. A mechanical seal prevents leakage. Further data on request to manufacturer.

The New York Air Brake Company, Aurora Pump Div, Aurora, Ill

Electrical insulation material

920 • Called *Supramica* ceramoplastic, this material consists of pulverized synthetic mica bonded with high-grade electrical glass. It is claimed to withstand effects of radiation and temperature to 1000 F without losing its properties. *Supramica* ceramoplastic products are said to provide total and permanent dimensional stability, low electrical loss and high arc resistance. They are impervious to water, oil and organic solvents. The material is being used in nuclear projects and is expected to find wide use as an insulator for electronic components where extreme temperatures are encountered. Full details on request.

Mycalex Corporation of America, Box 311, Clifton, New Jersey

Metal-enclosed switchgear

921 • This low-voltage equipment is available in both indoor and outdoor arrangements. The switchgear features new circuit breakers rated 600 amps, 25,000 aic at 600 v (LA 25) and 1600 amps, 50,000 aic at 600 v (LA-50).

Reversible panels are mounted on each breaker compartment permitting doors to be closed with breakers in connected, test or disconnected position. Each breaker compartment is barriered from the bus compartments independently of the breaker frame and from adjoining breaker compartments by a double steel wall.

Outdoor unit has a weatherproof housing. Full data in bulletin 18B8283.

Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wis.

For more data on these items, use post cards p 163. Identify your request with item number.

CHECK THESE TOO . . .

Panel instruments . . . . . p 168
Air, oil booster cylinder . . . . . p 168
Stuffing box lubricator . . . . . p 170
Common trip circuit breaker . . . . p 174
Non-skid plastic abrasive . . . . . p 176
Pressure-atomizing oil burner . . . p 176
Hydraulic-cylinder packings . . . . p 178
Redesigned CO_2 system . . . . . p 178

Breech-Lock Is The Only High-Pressure Steel Valve...

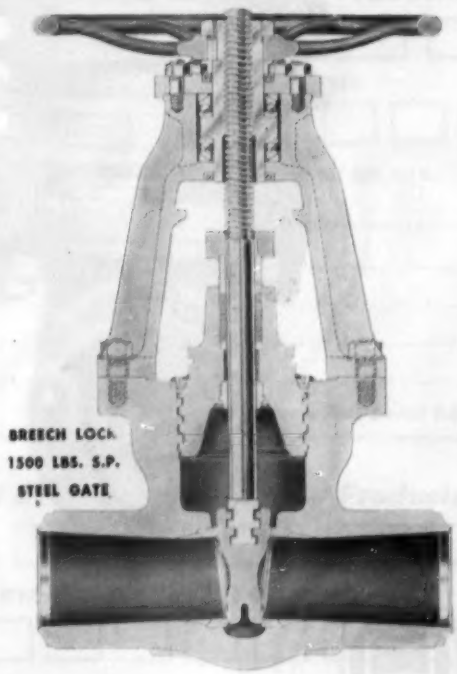
- ***That Has No Gaskets***
- ***No Bolts***
- ***No Threads***
- ***Yet Can Be Readily Disassembled In The Field***

Pressure-tight — without expensive maintenance. Designed to eliminate *all* the common causes of steel valve failure. That's Breech Lock — the exclusive, patented high-pressure valve with the positive *locking* action.

On the Breech Lock Bonnet are four rows of heavy, precisely machined lugs. Matching lugs are in the body. When the bonnet is turned 45°, the lugs intermesh— lock together to carry full internal pressures and distribute stress evenly. A seal weld, which can be readily chipped away with an air-hammer, is applied at the bonnet-joint.

There are no sealing surfaces to corrode, no flanges, gaskets, or bolts to require periodic maintenance. Result — *peak* valve efficiency under the severest conditions.

Breech-Lock Valves have been in continuous service for years in the largest high-temperature, high-pressure power plants with amazing operating results. Write for information to The Lunkenheimer Co., Cincinnati 14, Ohio.



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LUNKENHEIMER

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pounds

NOT GUESSES

Builders Shuntflo Steam Meter keeps track of steam costs by showing you *where* steam is going and *how much*. Write for Bulletins. Builders-Providence, Inc., 354 Harris Ave., Providence 1, R. I.

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AIR CONDITIONING AND REFRIGERATION

1 **Air-conditioning units.** Centrally-located cabinet-type models in capacity range of 600 to 48,000 cfm are described in illustrated 20-p bulletin S127. Included are tables, graphs, selection data and full specs. American Blower Corp, Detroit 32, Michigan.

2 **Gas-powered air conditioners** are subject of 6-p bulletin containing data on 3 to 10 ton units. Illustrations, cutaways, operating cost chart. Cobell Industries, Inc., Box 1157, Fort Worth, Texas.

3 **Steam humidifiers.** Illustrated 16-p bulletin 500 contains tables, charts, physical data, selection and installation info. Armstrong Machine Works, Three Rivers, Michigan.

5 **Refrigeration valves,** filters and driers are subject of illustrated 30-p catalog W-3-S. Contains charts, selection data, capacity tables. A-P Controls Corporation, 2480 N 32nd St, Milwaukee, Wisconsin.

6 **Brass valves, accessories** and fittings for refrigeration and air-conditioning applications are detailed in 24-p catalog R-5. Incorporates recent technical data on relief valves, check valves and low-micron testing of standard line and globe valves. Superior Valve & Fittings Co, 1509 W Liberty Ave, Pittsburgh 26, Pa.

BOILERS AND AUXILIARIES

7 **Steam generators,** with capacities from 50,000 to 150,000 lb steam per hr, are described in 4-p bulletin B-55-4. Units offer working pressures to 1500 psi without superheat or to 1100 psi with superheat. Foster Wheeler Corp, 165 Broadway, New York 6, New York.

8 **Packaged steam generators** in sizes from 10,000 to 46,000 lb steam per hr, are described in 14-p bulletin PG-55-3. Gives capacities, dimensions, instrumentation, accessories, sectional drawings, photos. Foster Wheeler Corp, 165 Broadway, New York 6, New York.

9 **Water-tube boilers** and steam-generating equipment are discussed in 12-p bulletin. Contains photos and descriptions of water-cooled furnaces, superheaters, economizers, air preheaters and steam washers. Edge Moor Iron Works, Inc, division of Condenser Service & Engineering Co, Inc, Hoboken, New Jersey.

10 **Plastic firebrick.** Illustrated 8-p bulletin 65 lists specific advantages, characteristics and typical applications of five grades of firebrick. Plibrico Co, 1500 N Kingsbury St, Chicago 14, Illinois.

11 **Deaerating heater,** for use in smaller plants where heating of feedwater and removal of corrosive gases are necessary. Illustrated 4-p bulletin WC-118 contains sizing charts, cross-sectional diagrams, accessories. Graver Water Conditioning Co, 216 W 14th St, New York 11, New York.

12 **Safety devices** for hot-water space heating boilers is subject of 8-p illustrated bulletin P-30. Gives recommendations for use of pressure relief valves, low water cut-offs, boiler-water feeders and feeder cut-off combinations. McDonnell & Miller, Inc, 3500 N Spaulding Ave, Chicago 18, Illinois.

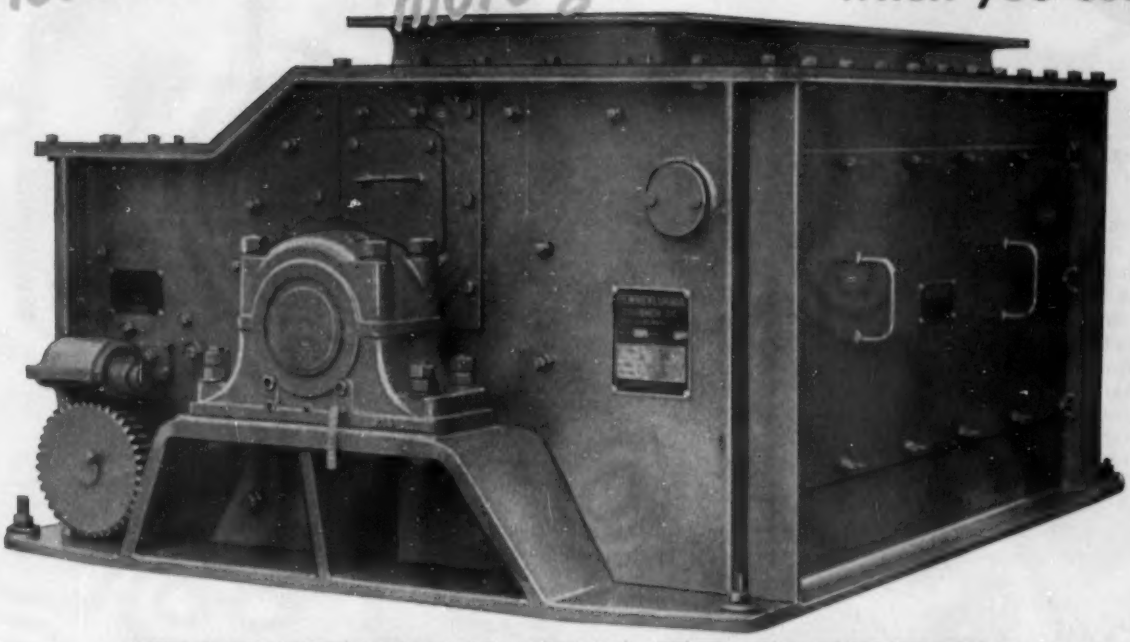
ELECTRICAL EQUIPMENT

13 **Power transformers.** Heavily illustrated 24-p bulletin covers single-phase core form units of 10,000 kva and above, and three-phase units 15,000 kva and above. Contains design features, construction details, principal accessories. Pennsylvania Transformer Co, Canonsburg, Pennsylvania.

14 **Ballasts** for fluorescent lamps. Illustrated 8-p bulletin UMC-7-55 is intended as a guide to basic data on ballasts for application and design. Detailed drawings and photos. Universal Manufacturing Corp. 29-51 E 6th St, Paterson 4, New Jersey.

(Continued on page 214)

less overgrinding
more granulation
when you use



PENNSYLVANIA COAL GRANULATORS

(patented ring hammermills)

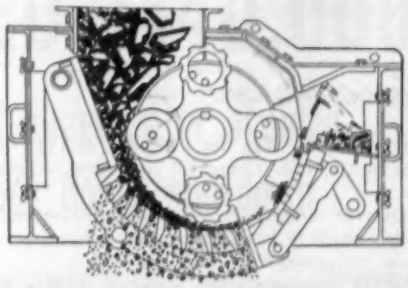
Pennsylvania snubs the rings

. . . so that they roll firmly and smoothly over the coal, producing a uniform, granular product with a minimum of fines. This feature, that prevents the rings from bouncing and scrubbing, is an exclusive (patented) Pennsylvania feature, and a lot of operators have found it so important that they specify Pennsylvania whenever this type of machine fits the job.

Easy Positive Cage Adjustment

Did you ever try to push anything with a wet string? That's about what it's like when you try to back off a frozen cage with a chain type adjustment. Cage adjustment of the Pennsylvania Coal Granulator is made with a ratchet wrench and worm gear assembly through a link and lever mechanism that makes adjustment to or from the rings easy and positive. Send for Bulletin #9003.

PENNSYLVANIA CRUSHER DIVISION
Bath Iron Works Corporation
West Chester, Pennsylvania



PENNSYLVANIA

BRADFORD BREAKERS
HAMMERMILLS
IMPACTORS • JAWS
SINGLE ROLLS

PE-196

George Edwards' Scrapbook

Now, petroelectric power

Not water, but crude oil may soon turn turbines down in South America. Brains in back of the project is John Williams, president of Williams Brothers of Tulsa, Okla. I believe his idea is interesting to power engineers.

Oil fields in Bolivia are nearly three miles above Arica, Chile. Ten- and eight-inch lines connecting these two places would drop 15,000 ft within a 48-mile stretch. But such a sharp drop brings up problems. Williams explains the pressure at Arica would build up to 4000 psi. So his answer is to have crude oil do work, by turning turbines and generating electric power the same as any hydro station. Thus power station also becomes pressure-reducing station. Electric power from these generators will supply Arica, a city of 30,000 people. This idea might be applied to any fluid—no doubt some of us can cash in on it.

Explosion guard

Now there's an electronic device that detects an explosion almost *before* it occurs—and acts to put it out. A photoconductive cell, sensitive to the infrared light, "sees" the explosion and, in less than a millionth of a second, acts to release a fluid that vaporizes and puts out the explosion. The device is already being built into four military planes and it's expected to find wide use with ground-fuel storage tanks and pumping stations. In case you are interested, it is manufactured by Electronics Corporation of America, Cambridge, Massachusetts.

Times have changed

Dropped into a friend's office the other day and saw this letter hanging on the wall. Thought it might give you readers a laugh.

To all employees—Due to increased competition and a keen desire to remain in business, we find it necessary to institute a new policy—effective immediately.

We are asking that, somewhere between starting and quitting time, and without infringing too much on the time usually devoted to coffee breaks, lunch periods, rest periods, story telling, ticket selling, vacation planning and the rehashing of last night's TV programs, each employee endeavor to find some time that can be set aside and be known as the "work break."

To some this may seem a radical innovation, but we honestly believe the idea has great possibilities. It can conceivably be an aid to steady employment, and might also be a means of assuring regular pay checks.

While the adoption of the work-break plan is not compulsory, it is hoped that each employee will find enough time to give the plan a fair trial. It is also hoped that those not in favor of adopting the work-break idea will have fully completed their vacation plans.—The Management

Balloons and injectors

Did you know that the feedwater injector was invented to supply water to the boiler of a steam-propelled balloon? Henri Giffard, French aeronaut, unable to find a pump light enough to fly, applied his knowledge of fluid flow, velocities and pressures, to reproduce the injector. Frank Taylor of the Smithsonian Institution is pointing to the injector which Giffard sent to the United States with his application for a patent. The patent was granted in 1860. Pictured over the shoulder of the interested visitor is William Sellers, who first manufactured the Giffard injector in this country.

After long years of service injecting water into the boilers of locomotives, tractors, hoisting engines, steam shovels and stationary steam plants, the injector is finding new uses today. It can supply very hot water at high pressures for cleaning food-processing machines, oil-refinery heat exchangers, and other hard-to-clean equipment. So you can see that good ideas are not wasted. This one didn't take to the air, but it has been a very important item in our field. See it on your next visit to Washington, D. C.

Don't overlook ideas

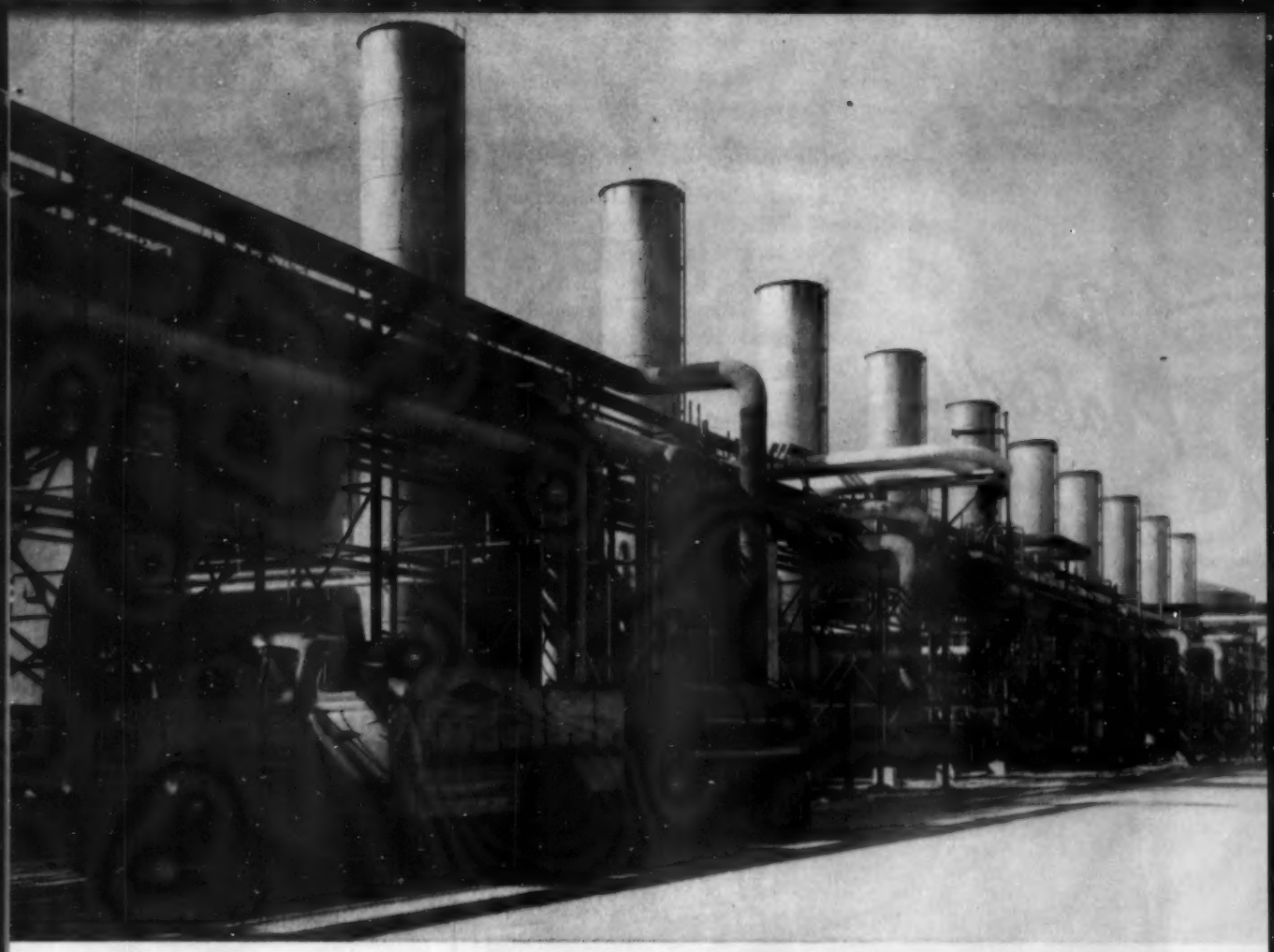
We cannot afford to make a displaced person out of the man with the *big idea*. No matter how well-organized or how technically sophisticated we become, the fact is that progress originates in creative thought, a purely personal attribute.

—C H Greenewalt, president of E I du Pont de Nemours & Co

Think about this

Dr Norman Vincent Peale quotes this recipe in his book, *The Power of Positive Thinking:* "The way to happiness: keep your heart free from hate, your mind from worry. Live simply, expect little, give much. Fill your life with love. Scatter sunshine. Forget self, think of others. Do as you would be done by. Try this for a week and you will be surprised." My question is: What're we waiting for?

George Edwards
Engineer



OPERATOR SAVED $440,000

DOWELL chemical cleaning of superheater avoided costly retubing and two-week boiler shutdown

Scale deposits had caused tube failures in the superheater of this 175,000-pound-per-hour boiler. To clean mechanically or replace the tubes would have required a two-week shutdown, costing $1,700 per hour in lost production. Instead, the operator chose Dowell chemical cleaning.

Experienced Dowell engineers developed special cleaning techniques for the nondrainable superheater, then used job-tailored Dowell solvents. The unit was restored to top operating condition in just 3½ days. Total saving to the operator, in cost of outage time and replacement parts, was approximately $440,000!

Dowell engineers hold downtime to a minimum by introducing solvents through regular connections. Extensive dismantling and scaffolding are not needed.

By removing corrosion products, chemical cleaning helps eliminate boiler tube failures due to overheating or galvanic attack. Prevent unscheduled shutdowns . . . keep your equipment operating at top efficiency . . . start a regular program of Dowell chemical cleaning *now*.

For more information, call any of the 165 Dowell offices in the United States and Canada. Or write directly to Dowell Incorporated, Tulsa 1, Oklahoma, Department I-23.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

The Peabody PK-54 Burner

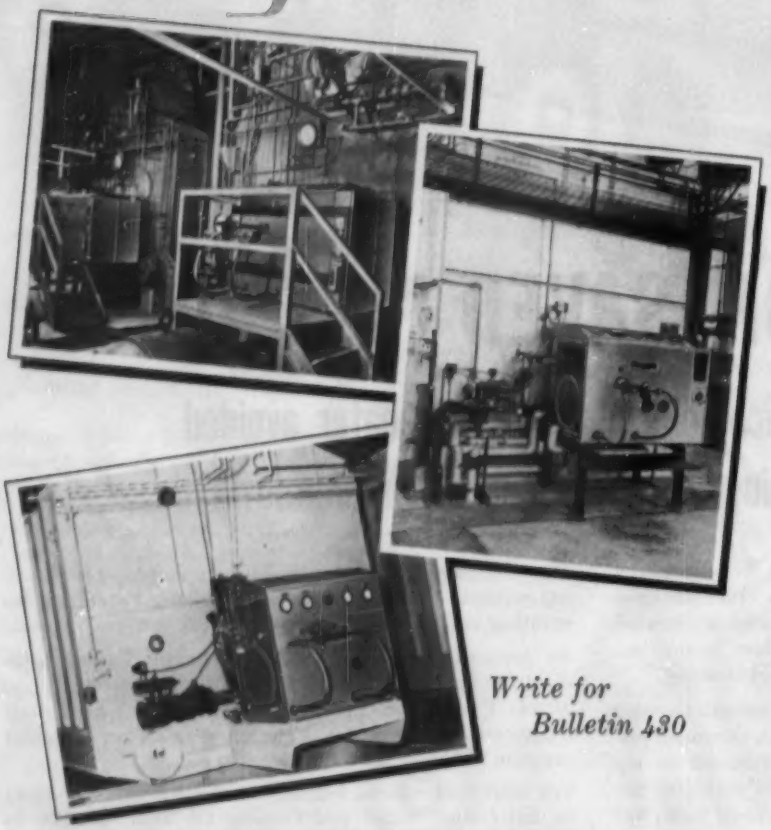
Wide Range Acceptance —

The completely integrated compact design offered by Peabody in the PK-54 Burner is based on years of experience with automatic burners. The PK-54, a modern, efficient, and improved version of the original PK Burner, has gained universal acceptance with users throughout the United States, Mexico, South America and Europe.

Safety Record —

Over 200 units now in operation are turning in enviable safety and performance records . . . *records that cannot be equaled!*

Positive proof that careful planning, design and engineering based on experience pays off for the user.



Write for Bulletin 430

PEABODY ENGINEERING CORPORATION

580 FIFTH AVENUE, NEW YORK 36, N. Y.

OFFICES IN PRINCIPAL CITIES

PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

S-165

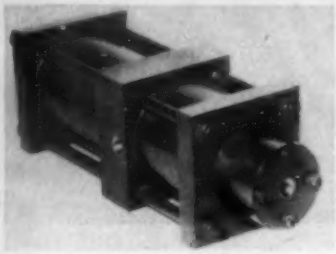
More EQUIPMENT NEWS

Begins on page 154

Panel instruments

940 • These panel instruments are said to permit up to 50% more scale length in the same space as conventional round or square faced meters. Features claimed include longer dial arc, larger numerals and longer pointer. Units are available in 2½ and 3½-in. sizes, and meet standard ASA/JAN dimensional requirements. Data on request.

Marion Electrical Instruments Co, Manchester, New Hampshire

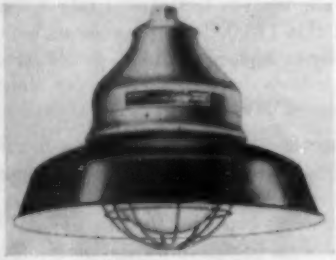


Air, oil booster cylinder

941 • Air and oil operated booster cylinder will build up fluid pressure to 1951 psi using input pressure of 100 psi or will boost pressure as high as 1660 psi using an input of 80 psi. It will develop a ratio of 19.7. Its 5-in. air cylinder drives a 1⅛-in. hydraulic ram that in turn delivers 0.994 cu in. per inch of stroke. The cylinder return is accomplished by air action.

Airmatic Valve, Inc, 7317 Associate Ave, Cleveland 9, Ohio

For more data on these items, use post cards p 163. Identify your request with item number.



Explosion-proof light

942 • Explosion-proof industrial lighting fixture is for use in Class I, Groups C and D hazardous locations. The fixtures have mogul screw base porcelain lamp recep-

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL STEEL VALVES

FIG. 11323—1500-Pound Motor Operated Steel Pressure Seal Gate Valve

FIG. 3003 WE—Steel Gate Valve For 300 Pounds W.S.P.

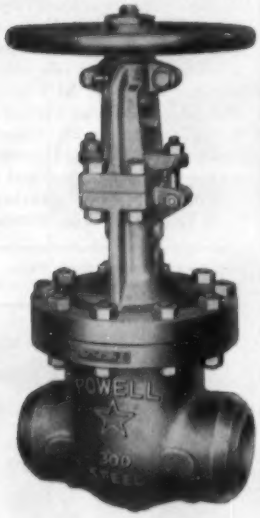


FIG. 11365—Steel Pressure Seal Horizontal Lift Check Valve For 1500 Pounds W.S.P.

FIG. 1314-A—1500-Pound Integral Bonnet Steel "Y" Valve

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Wherever flow requires dependable control, there's the place for Powell Valves. Powell can supply just the valve you need, for Powell probably makes more kinds of valves and has solved more valve problems than any other organization in the world.

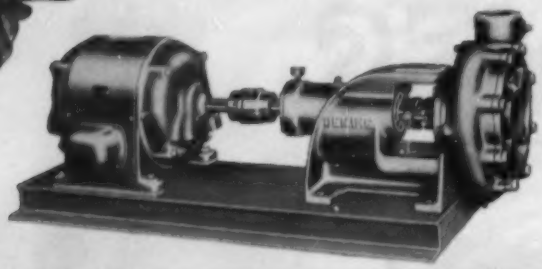
Shown above are just a few Powell Steel Valves. Investigate their many outstanding features . . . *and the complete line* of quality valves famous for dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

The more you need pumps, the more you need...

DEMING
INDUSTRIAL PUMPS



here's an example: Optional features of the Deming Fig. 4011 Centrifugal Pump (shown above) extend its scope of uses to handling a wide variety of different kinds of liquids . . . corrosive or non-corrosive. In many cases, this versatile pump eliminates the need for higher-cost pumps built entirely of corrosion-resistant metals. Other optional features include a choice of impellers and either stuffing box, or mechanical seal construction. BULLETIN No. 4011 explains this popular Deming Pump. Send for copy.

NOTE THE SCOPE OF THE DEMING LINE

- Small side suction Centrifugal Pumps
- Centrifugal Pumps with separate liquid end
- "Motor-Mount" Centrifugal Pumps
- Split case Centrifugal Pumps
- Self-priming Centrifugal Pumps
- High pressure Multi-Stage Pumps
- "Oil-Rite" Duplex and Triplex Pumps
- Condensation Return Units
- Vertical Turbine Pumps
- Vertical Sump Pumps
- Vertical Sewage Pumps
- Submersible Pumps

A Deming Distributor is near you for prompt service

THE DEMING COMPANY
647 BROADWAY • SALEM, OHIO

75th ANNIVERSARY DEMING PUMPS

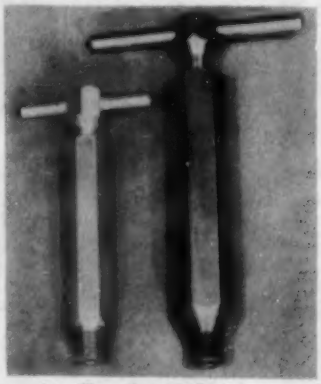
More EQUIPMENT NEWS

Begins on page 154

tacles for 300 or 500-w lamps. Construction includes threaded joints except at globe where the flange is ground and clamped against the surface by means of a threaded ring. For security and to lock against turning, set screws are provided at all threaded joints.

Housings are fabricated of cast aluminum alloy. Guards, protecting globes of clear impact-resisting glass, are of cadmium-plated steel wire. Details on request.

The Pyle-National Co, 1340 N Kostner Ave. Chicago 51. Ill.



Stuffing box lubricator

943 • Extension lubricator is used for injecting lubricant as packing in pump shaft stuffing boxes. Previously made for individual customers at their request, the lubricator is now available as a stock item. Made of brass or cadmium-plated steel, the accessory comes in two over-all lengths—6⅝ and 8 7/16-in. NPT thread connector. The longer model with larger lubricant barrel is available with either ¼-in.-18 or ⅜-in.-18 NPT thread connector. Details on request to the meter and valve division.

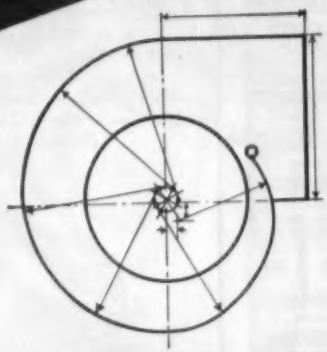
Rockwell Manufacturing Co, 400 N Lexington Ave, Pittsburgh, Pa.

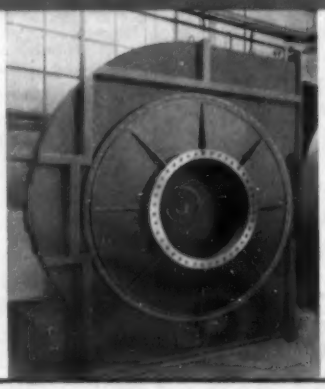
For more data on these items, use post cards p 163. Identify your request with item number.

Displacement controller

944 • Instrument is used for automatic alarm or closed-loop control involving pressure, weight, stress, motion or any other quantity measurable by differential transformer transducers. Features claimed

GREEN *Airfoil type* DRAFT FAN





6 DIFFERENT DESIGNS

MANY VOLUME-PRESSURE COMBINATIONS

Thus you can obtain from Green not only the modernized 1955 version of the AIRFOIL Type of Fan made by us back during the World War 1 era but you can probably get much closer to your actual draft requirements *at high guaranteed efficiencies* than with other types of fans.

Six different designs provide a dozen combinations of diameter, width, shroud angle, blade angle, blade length and other influencing factors. You will be getting exactly what you need in the way of volume, pressure, and speed at the most efficient point.

When writing for complete details of the modernized redesigned line of Green GALEX AIRFOIL Type Draft Fans, tell us as much about your requirements as you can disclose at this time. It will help us to choose the best GALEX Fan for your anticipated draft problem.

GREEN THE AIRFOIL TYPE FAN Galex FAN

GREEN POWER AND PROCESS PLANT EQUIPMENT

FUEL ECONOMIZER COMPANY,
BEACON 3, NEW YORK

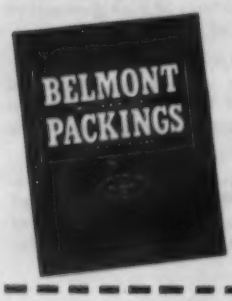
CHECK YOUR NEAREST BELMONT DISTRIBUTOR

He'll Solve Your Packing Problems...Pronto

Belmont Packings . . . compounded like a doctor's prescription . . . answer the individual packing needs of industry.

There's no cure-all in the Belmont Line; every style, every construction is made for some specific SEALING service. Belmont Packings seal better, last longer because six decades of experience—in just making packings—stands behind every Belmont Recommendation. Try them and see!

The nearest Belmont Distributor will supply your needs from ample local stocks. He'll save you money on warehouse and transportation costs. You can buy large or small quantities as needed. His service facilities reduce buying and accounting costs. And he'll help to keep your equipment and machinery *SEALED* and running smoothly. Get the packing in the blue box with a flock of orange trade-marks.



When it SEALS right—stays TIGHT . . . you know it's Belmont made!

4-R-3

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Butler & Sepviva Streets — Philadelphia 37, Pa.

Without obligation — send us information as checked:

- ☐ Crisscross Braid Folder
- ☐ #54 Condensed Catalog
- ☐ Bel-Vee Packing Folder

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Company .....
Address .....
City ..... State .....

☐ SEND NAME and ADDRESS of NEAREST BELMONT DISTRIBUTOR

More EQUIPMENT NEWS

Begins on page 154

by manufacturer include regulated excitation voltage for the transducer, electrical zero and sensitivity adjustments, and a 4½-in. contact-making meter with adjustable limit contact.

In operation, relay is energized whenever measured quantity equals or exceeds preset limit and opens when quantity falls below the limit. A pilot light indicates relay position at all times.

Relay contacts are rated at 5 amps, 250 v, ac. Maximum, full scale sensitivity is 0-.025 in. using typical differential transformer or 0-5 lbs using company's *Series 140* load transducers, according to manufacturer. Further details on request.

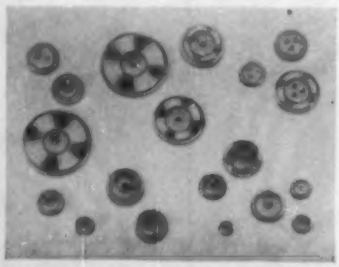
Daytronic Corp, 216 S Main St, Dayton 2, Ohio

Plug valve for 700 F

945 • Plug valve is designed for use in petroleum refineries and allied industries where liquid fuel is burned at high temperatures to 700 F. No castings are used for pressure parts of these valves. All parts are machined from solid ingots. Body is steel and trim is stainless steel. Available in ⅜, ½ and ¾-in. sizes.

National Airoil Burner Co, 1284 E Sedgley Avenue, Philadelphia 34, Pa.

For more data on these items, use post cards p 163. Identify your request with item number.



Compression-type end seals

946 • Expanded line of hermetically sealed compression-type end seals are available in a broad range of dimensions in flared tube or pierced terminals with single or multiple lead terminations. They are widely used for hermetically sealing condensers, resistors and other tubular components. Manufacturer states that these seals possess extraordinary immunity to shock, vibration and pressure changes. No special skill is required to apply and assem-

Improve Heat Transfer ...Reduce Maintenance

by Eliminating Corrosion

Even when an efficient deaerator removes free carbon dioxide from your system, additional CO_2 produced by decomposition of bicarbonates and carbonates remains to cause return line corrosion. Residual oxygen causes pitting. Protecting against both CO_2 and O_2 considerably reduces the cost of replacing and maintaining steam and return lines. Keeping the system free of corrosion products assures high heat transfer efficiency.

One series of Allis-Chalmers corrosion inhibitors solves this problem by neutralization. These materials are blends of the most effective amines selected according to the volatility characteristics required by each steam condensate system. Protection is provided against both CO_2 and O_2 at the points where it is needed.

Although recommendations for your specific needs can be made only after thorough analysis, you can get more information about use of this series by obtaining a copy of Allis-Chalmers Water Conditioning Informational Bulletin 50. Get a copy from your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

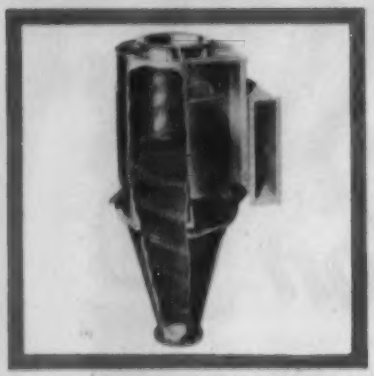
ALLIS-CHALMERS

Water Conditioning—Chemicals, Equipment, Service—for more than 25 years

A-C ALLIS-CHALMERS

A-4404

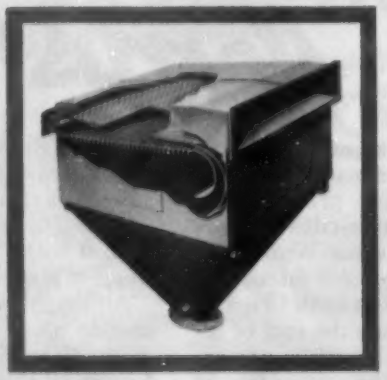
Electrode Breakage is no problem in Buell "SF" Electric Precipitators



Buell Cyclones offer two "extra-efficiency" advantages: (1) exclusive shave-off which harnesses double-eddy and puts it to work, and (2), large diameter design which eliminates clogging.

Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations. Ideal for boilers from 100 to 2000 BHP.

Besides eliminating efficiency drops and "shutdowns" due to electrode breakage, Buell's unique Spiralectrode permits higher and more constant emission, extra efficiency. Also, Continuous Cycle Rapping—another Buell exclusive—keeps electrodes constantly clean for maximum efficiency...at all times!



For more specific data about Buell's *extra efficiency*, write Dept. I-50,
Buell Engineering Company,
70 Pine Street, New York 5, N. Y.

buell

MECHANICAL ELECTRICAL

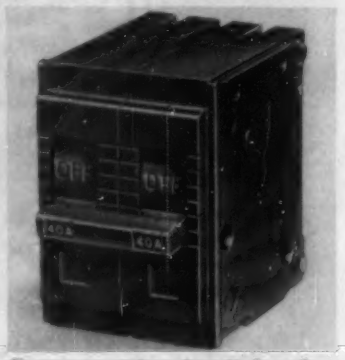
Experts at delivering Extra Efficiency in
DUST COLLECTION SYSTEMS

More EQUIPMENT NEWS

Begins on page 154

bly is rapid as all metal parts are tin dipped for easy soldering. Full data on request.

Electrical Industries, div of Amperex Electronic Corporation, 44 Summer Ave, Newark 4, N. J.



Common trip circuit breaker

947 • Two-inch breaker consists of two pole units with an interlocking trip mechanism assembled as a single unit. It will fit load centers or panelboards designed to take one-inch *Type R* or *Type TQL* circuit breakers.

The two-pole *Type TQL* is available in six ratings from 10 to 50 amps for 120/240-v, ac operation. It has an interrupting rating of 5000-amps ac.

Excessive current in either pole of the breaker trips both poles simultaneously, thus greatly reducing risk of accidental shock. Thermal and independent magnetic trip elements provide protection against both short circuits and sustained harmful overloads. Momentary overloads, such as motor starting, will not trip the breaker.

General Electric Company, Trumbull Components department, Plainville, Connecticut

For more data on these items, use post cards p 163. Identify your request with item number.

Heavy-duty casters

948 • Improved design of heavy-duty casters offers complete sealing to prevent loss of lubricant and entry of foreign matter, according to manufacturer.

Recommended for power-pulled assembly

Calumet Division, Calumet and Hecla, Inc., Calumet, Michigan

"Cities Service Heat Prover Played A Major Role In Our Expansion Program"

Miners and refiners of copper, the Calumet, Michigan Division of Calumet and Hecla, Inc., relies on two power plants to operate its many mines, reclamation plants, mills, manufacturing facilities and mine rehabilitation projects.

The two plants, located at Lake Linden and Hubbell, were recently brought up to date. The Lake Linden plant now has modern steam generating equipment fired with pulverized coal. The Ahmeek plant was equipped with new coal distributors for its underfeed stokers and new plastic monolithic furnace settings.

This modernization program, along with a planned preventive maintenance program which is now being put into effect, is expected to raise the KW capacity of these plants from 20 megawatts to 30 within the next few months.

The Cities Service Heat Prover has played a major role in this improvement program. It is used extensively to examine combustion conditions in the furnaces, check station instruments, and guard against air infiltration through boiler settings and duct work, thus enabling plant personnel to operate the equipment constantly at design efficiencies or better.

Says Power Superintendent, Robert Hein: "The portable Cities Service Heat Prover has proved invaluable in our operation. We are now using 150,000 tons of coal per year and operating at boiler efficiencies around 86%. By giving us a quick, accurate check on our firing conditions, the Heat Prover has been directly responsible for much of this record."

The Heat Prover is supplied and maintained free by Cities Service. For further information write Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.

Calumet Reclamation Operation reclaims stamp sands processed years ago and dumped into lake. Further processing will extract copper. For power, dredge relies on the Calumet Division's Lake Linden Power Plant.

Taking Readings With Heat Prover has helped Calumet Division achieve 86% boiler efficiency. Will aid further in raising KW capacity from 20 to 30 megawatts. The unique instrument enables maximum heat benefits from coal.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

ROTOJET®

Junior TUBE CLEANERS for SMALL TUBES

The new Rotojet Junior Tube Cleaner has unusual power to clean small tubes quickly. This convenient, compact, self-contained cleaner, designed for one-man operation, needs very little headroom. Tube bundles can be cleaned without removal from shell.

Roto expanding heads and brushes with replaceable wearing elements save money and assure thorough cleaning of straight and curved tubes.

Send for Bulletin J-410 for full details.

S328 ROTOJET Junior Water-driven Motor, flexible coupling, and expanding scraper

C434 ROTOJET Junior Air-driven Motor, flexible coupling, expanding brush.

S32 ROTOJET Junior Air-driven Motor, cone cutter, universal joint.

ELLIOTT COMPANY-ROTO DIVISION

153 Sussex Avenue • Newark 1, N. J.

More EQUIPMENT NEWS

Begins on page 154

line applications, the caster gives full protection where dirt, debris, water or other foreign matter pose maintenance problems. Design features claimed are: baffle ring that protects swivel bearings from dirt; grease retainer that prevents swivel lubricant loss through vertical leakage; and wheel bearing seal. Details on request.

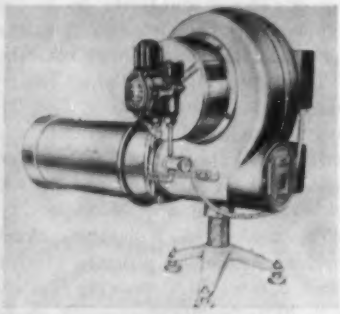
Bassick Co, Bridgeport 2, Conn.

Non-skid plastic abrasive

949 • Non-skid plastic abrasive composition called *Ferrox* is available for a wide range of safety applications. It is said to provide a low cost coverage, 40 ft to the gallon, and is recommended for concrete floors in washrooms, ramps, platforms, around machine areas or wherever there is a slipping hazard. Details on request.

American Abrasive Metals Co, Irvington, New Jersey

For more data on these items, use post cards p 163. Identify your request with item number.



Pressure-atomizing oil burner

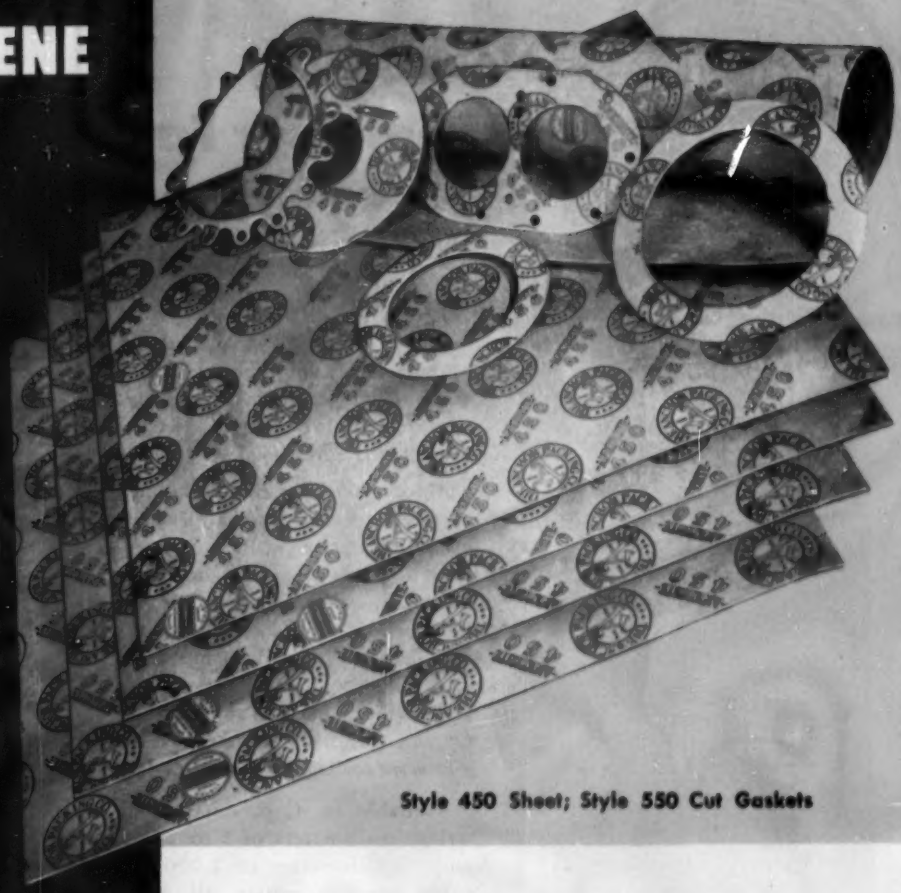
950 • Heavy-duty pressure atomizing oil burner has a capacity of 20 to 30 gallons and is approved for firing No. 2 or lighter oil. Features claimed by manufacturer include heavy-duty choke ring cast iron frame, sealed-for-life motor and electronic combustion controls. Burners are designed to permit adjustment of nozzle position while burner is in operation.

Iron Fireman Manufacturing Co, W 106th St, Cleveland 11, Ohio

Geared-head wrench

936 • Compact 4:1 geared-head wrench is designed for heavy assembly and disassembly work requiring rotary effort over

ANKOPRENE BONDED SHEET and CUT GASKETS



Style 450 Sheet; Style 550 Cut Gaskets

widely used for their RESISTANCE TO OIL!

This compressed asbestos sheet packing of The Anchor Packing Company, homogenous in construction, contains an oil-resisting compound. It is approved by the Underwriters' Laboratories.

Ankoprene sheet is used in services involving petroleum oils and distillates, as well as gasoline and all petroleum derived solvents. Ankoprene gaskets are ideal on refrigerating compressors handling Freon or other refrigerants.

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THE ANCHOR PACKING COMPANY

GENERAL OFFICES: PHILADELPHIA, PA.
FACTORIES: MANHEIM, PA. ELKHART, IND. MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

Here's Why Aeromaster Fans mean more satisfactory cooling equipment operation

Manufacturers and users of cooling equipment agree... Aeromaster Fans give outstanding service. Here are the reasons why.

Aeromaster Fans are *precision engineered,* adapted from high speed aircraft propellers. They have adjustable blade pitch and anti-flutter design . . . therefore, require less horsepower. And they last longer too, thanks to the exclusive Aeroloid blade coating to resist acids and alkalies, abrasion and weather. Overall result: Aeromaster Fans *give more cooling at lower cost.*

Available in 4, 6, or 8 blade styles, in diameters of 5 to 24 ft., with capacities up to 1,000,000 cubic feet per minute, all Aeromaster Fans are fully guaranteed.

Koppers also has trained engineering specialists available in principal cities, insuring prompt, expert Aeromaster Fan service. And Koppers is always ready to consult with you on special fan problems. Next time you plan a replacement of present fans, specify Aeromaster. And when you consider new equipment, call on Koppers . . . always eager to be of service.

KOPPERS

Aeromaster Fans

METAL PRODUCTS DIV. • KOPPERS COMPANY, INC. • BALTIMORE, MD. • This Koppers Division also supplies industry with Foot's Couplings, American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators and Gas Apparatus. Engineered Products Sold with Service

MAIL COUPON TODAY FOR COMPLETE INFORMATION

KOPPERS COMPANY, INC., *Aeromaster Fans,* 269 Scott St., Baltimore 3, Md.
Gentlemen: Please send me detailed information on Aeromaster Fans for

.....
(name and type of equipment to be cooled)

Name .....

Title ..... Company .....

Address .....

City ..... Zone ..... State .....

More EQUIPMENT NEWS

Begins on page 154

200 ft lbs. It is an intermediate unit for use with ratchets, torque wrenches, sockets and attachments. Torque is produced through planetary gears. Known 4:1 ratio permits its use as a multiplier for torque wrenches.

Unit has a drop-forged heat-treated chrome-moly steel head. Head and shafts are sealed and lubricated for life.

Bonney Forge & Tool Works, Allentown, Pennsylvania

Hydraulic-cylinder packings

931 • Chemically-inert piston cup, U-cup and flange packings are designed to solve hydraulic cylinder packing problems. Made of DuPont *Teflon,* they are said to provide positive protection against corrosive action of all types of synthetic non-flammable fluids. They can be used at operating temperatures to 350 F and are self-regulating to compensate for pressure.

Piston-cup packings in a standard range of nominal cup sizes from 1 to 12 in. or on specification, are recommended for pressures to 2000 psi. U-cup packings furnished to piston or cylinder specifications are recommended for pressures to 1500 psi. Flange packings are available to specification for pressures to 2000 psi.

Crane Packing Co, Dept PRN, 1800 Cuyler Ave, Chicago, Ill.

For more data on these items, use post cards p 163. Identify your request with item number.

Redesigned CO_2 system

929 • Pressure-operated CO_2 fire-extinguishing system protects equipment in enclosed spaces. It is suitable for Class B or C hazards (flammable liquid or electrical equipment). System operates on a rate-of-temperature-rise principle. It employs CO_2 at 850 psi both for its power and its fire-extinguishing agent. Apparatus is self-contained and requires no outside power source.

Claimed features include: (1) completely-enclosed operating parts (2) elimination of falling weights previously required to trip the system (3) no replacement of parts after operation (4) visual inspection of CO_2 cylinders and (5) testing of all vital operating parts without discharging cylinders.

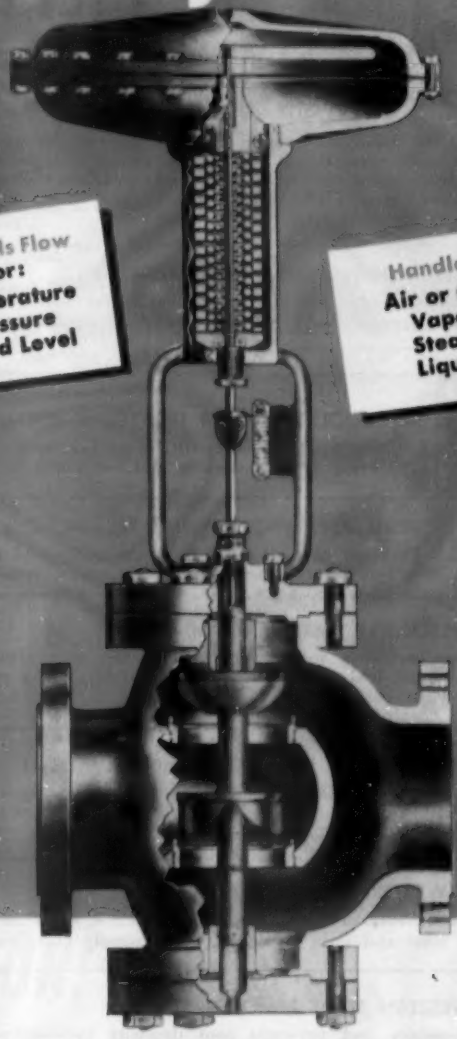
Walter Kidde & Company, Inc, Belleville 9, New Jersey

For All Types of Systems...

BS&B Type 86 Diaphragm Control Valve Is The "Workhorse" Of The Industry!

Controls Flow For:
Temperature
Pressure
Liquid Level

Handles:
Air or Gas
Vapor
Steam
Liquid



- ✓ **Wide Range of Application**
- ✓ **Wide Selection of Trim Characteristics**
- ✓ **Wide Rangeability**
- ✓ **Double Port—½" to 16"**
- ✓ **Single Port—½" to 8"**
- ✓ **Reversible Inner Valves**

Take Both The GUESS And The WORK Out Of Controls Sizing For Liquid, Steam And Gas Applications By Using BS&B's New And Exclusive Sizing Method, As Set Forth In Our New "Controls Sizing Manual." Available On Request From Your BS&B Representative.

SUFFICIENT OVER 50 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

SPECIFICATIONS

Body Size: Double Port, ½" to 16". Single Port, ½" to 8"
Body Style: Screwed Globe and Flanged Globe.
Pressure Range: 125 to 5,000 lbs. within body size limits.
Temperature: Up to 800° F.
Diaphragm Pressure: 3 to 15 lbs., standard.
Material: Body—high tensile cast iron, electric cast steel, or special alloys. Trim—bronze or 18-8 stainless steel or special alloys.

If You'd Like More Information, Contact Your Nearest BS&B Representative, Or Write To...

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-Q9
7500 East 12th Street
Kansas City 26, Missouri

Choose WESTERN
for Chemical Treatment of Water, Steam and Fuel

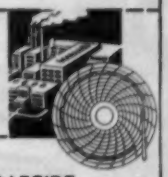
Look them over! Check your needs! Every Western product for treatment of water, steam or fuel is proved in use, technically formulated for each individual problem.

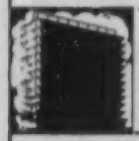
1 *Steam* + CORAVOL® = *Protection* (FROM CORROSION)

CORAVOL circulating throughout your steam system protects it from corrosive attack; cleans out rust deposits; increases heating and operating efficiency; reduces maintenance and labor costs. CORAVOL is the *original amine process* developed by Western Chemical Company.

2 WESTERN BOILER FEED WATER TREATMENT

Special formulas for each individual boiler water and operating condition to eliminate scale, corrosion and foaming.





3 COOLING WATER TREATMENT AND ALGAECIDE

Prevents scale deposit, corrosion, and algae growth in every type of cooling and condenser water system.

4 BRINE AND SWEET WATER TREATMENT

Prevents corrosion and protects tanks and equipment in refrigerating brine and sweet water systems.

5 WESTO HOT WATER TREATMENT

Stops corrosion and scaling in hot water supply tanks and lines, maintaining service without impairing potability.

6 WESTERN LIGHTNING TREATMENT

Disintegrates and removes scale quickly from water jackets, cylinder heads, condensers, compressors, lines, coils, pumps.

7 WESTERN ALUMINA NO. 45

Provides efficient coagulation in raw water ice manufacture, lime and soda softeners, water supply clarification.

8 WESTERN SOOT REMOVER

Removes and prevents soot deposits in combustion areas, thus increasing fuel economy and boiler capacity.

9 WESTERN FUEL OIL SLUDGE DISPERSANT

Eliminates sludge and moisture in fuel oil, effecting clean tanks, lines, and burners, and improved combustion.

Chemical Treatment for Water Steam and Fuel

WESTERN CHEMICAL COMPANY

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Kansas City 5, Missouri

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Western Chemical Company
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Kansas City 5, Missouri

Send me full information about products checked.

1 2 3 4 5 6 7 8 9

Name

Firm

Address

City Zone State

MARMADUKE

Continued from page 142

tain said he had to get to Memphis while the river was up. He was the boss, but I hated to sail with dirty boilers.

"At Memphis the current was so strong we couldn't stop the tow even after running out three check lines. This was done from a yawl manned by three deck hands. Two of them man the oars and one handles the 2½-in. Manila line. Men row ashore, pull the boat up on land and quickly throw a line around a couple of cottonwoods. While this is going on, the pilot tries to kill headway by ringing 'halfhead back' down to the engine room while he flanks the tow in toward the bank.

"After breaking all three check lines as fast as they were put out, we split the tow in two, letting half the loads coast downstream. A two-to-three-mile current makes checking one of those big tows almost impossible. After working fast and getting the tow's first half into Wolf Terminal, we chased the drifting half. We caught up with it a few miles downstream and brought it back. We took a chance on setting the barges free-astray at Memphis because of bridge piers, but there was nothing else we could do.

"Then, after picking up empties, we started on the long trip back to Pittsburgh with 15 empty barges. I thought we could relax going back, but I had a lot to learn about the *Aliquippa*. One hot night, at Chalk Bluff, between Memphis and Cairo, we ran into a swarm of mosquitoes. As luck would have it, I was sleeping on deck in my shorts, gasping for air. There was a dead calm and that swarm of man-eating insects dive-bombed me before I could make for cover. When I finally got to my room I was bloated like a whale and stinging all over.

"Proceeding up river we ran into a heavy fog so the skipper had to 'run the willows.' That means steering so close to shore that the sound of breaking tree branches scraping the tow is your sure way of not getting lost. So while running the willows in that fog we plowed into a log raft and its motor boat, hidden among the bushes. The men aboard were asleep and one man got drowned. That crash caused an 18-hour delay before we could continue to Cairo.

"One of the boilers had bagged a few minutes before getting to Cairo. The bag was about 14 in. in diameter and bulged down about 3 in. We tore down the brickwork, got torches, heated the bag to a cherry red and drove her back with sledge hammers. I've had those river boilers bag before when we were

STUBBORN!

Chase® Antimonial Admiralty Condenser Tubes
RESIST DEZINCIFICATION!

Dezincification holds no fears for the users of Chase Antimonial Admiralty Condenser Tubes! For *this* special alloy can give *year after year* of extra service under the most corrosive conditions!

Rugged testing in Chase laboratories, plus careful manufacturing in Chase mills, team up to give Chase Antimonial Admiralty a longer, healthier life span. To you, this can mean lower operating costs, fewer breakdowns, longer waits between tube replacements.

Enjoy these benefits! Insist on Chase Antimonial Admiralty!

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Baltimore	Cleveland	Houston	Milwaukee	Philadelphia	San Francisco
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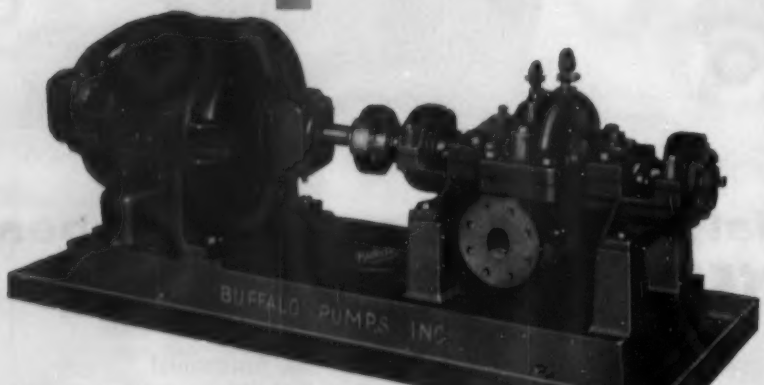
(†sales office only)

You're Actually Buying Low-Cost G.P.M.'s!

Put your pump buying on a basis of *overall costs*, for a true picture of what's the best buy! You're actually buying *delivered gallons*, over the life of the pump. How long the pump lasts—how efficient it is—how much it costs to maintain—are all factors that figure in your cost per delivered gallon.

Users of "Buffalo" Type "RR" Multi-stage Pumps have continued to enjoy low-cost gpm's, millions of gallons after installation. This is because of their inherent high efficiency, (which keeps your driving power requirements to a minimum) and simple, oversize construction (which keeps maintenance costs rock-bottom)—the "Q" Factor* which has been engineered into every "Buffalo" product for the past 78 years. It will pay you to write for Bulletin 980 and see why an "RR" is bound to give you low-cost gpm's in the long run!

NOTE: The "Buffalo" Pumps line is complete! There's a design for almost any liquid you may handle, under a wide range of hydraulic conditions. Let us know your problem—we'll mail you literature on the right pumps!



"Buffalo" 2-stage Type "RR" Pump for clear water at high pressures, and temperatures. Widely and successfully used on boiler feed for many years. 2 and 4 stage models to deliver up to 900 gpm at heads as high as 1500'. Bulletin 980.

"Buffalo" PUMPS

**The "Q" Factor—the built-in Quality which provides trouble-free satisfaction and long life.*

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Subsidiary of Buffalo Forge Company

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Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

MARMADUKE

Continued from page 180

caught out, away from civilization. Then I'd build a brick wall around the bag in the furnace. That would keep the heat away so we could fire up again.

"With everything put together at Cairo, we flanked out of the landing into midstream. While still backing, a boiler man-head gasket blew. We were lucky to get tied up on the far shore. There we cooled down and replaced the gasket.

"When we finally got to Evansville, Ind., our 'doctor' cracked one of her barrels. The doctor is a beam-type feed pump. She had a 6-in. vertical water cylinder at one end and a 12-in. vertical steam cylinder at the other. The two piston rods were attached to a horizontal beam. A heavy flywheel kept the doctor running steady. We laid over in Evansville long enough to shrink a band of iron around the cracked water cylinder.

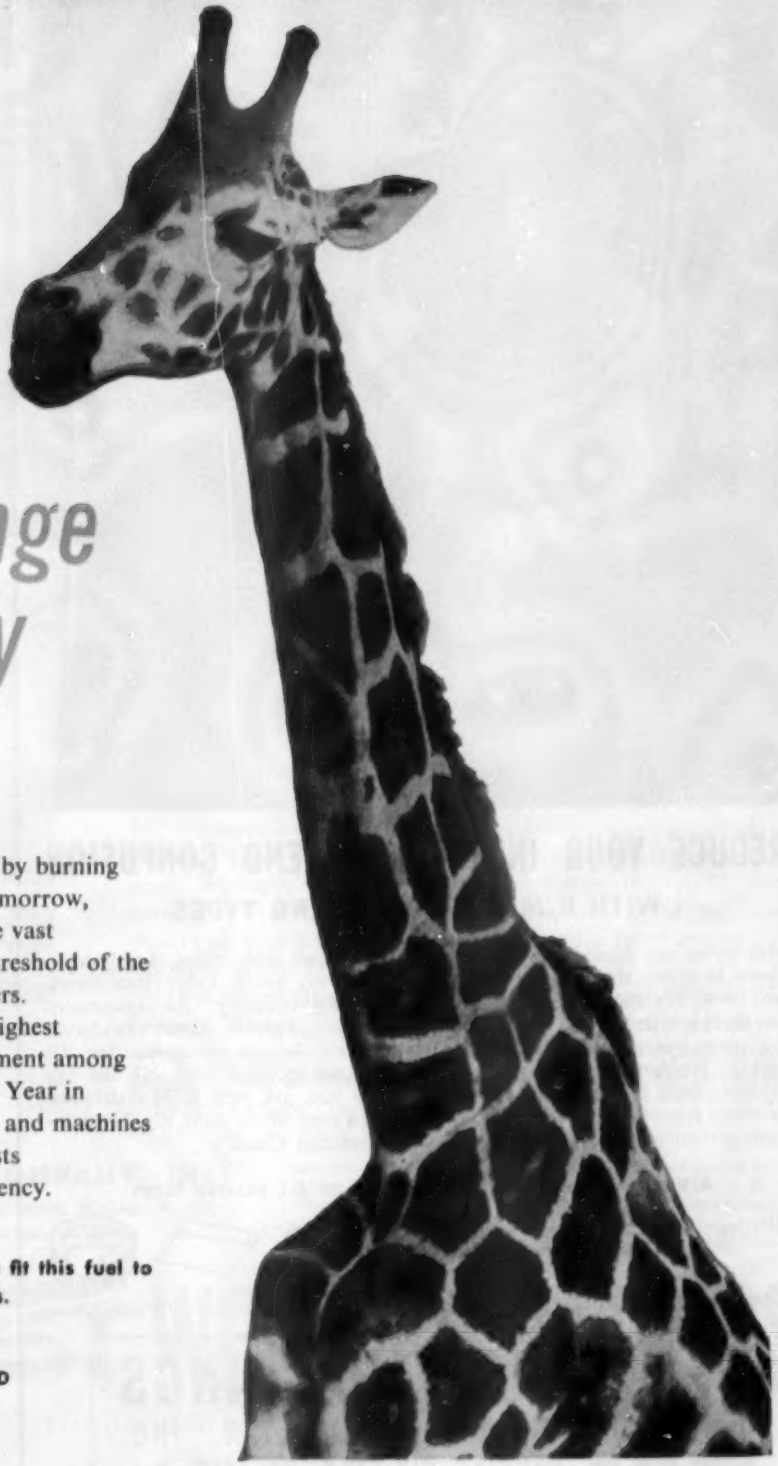
"Next big headache came when we started through Lock No. 39 above Louisville. One of the backing wires from the *Aliquippa* to a barge let go when the tow scraped a lock wall. That busted a ratchet chain. As the chain snapped back, it smacked one of my firemen who was off watch and on deck. That heavy chain fractured his skull and jaw, and broke his collarbone, for good measure. We rushed him ashore to the hospital.

"Next, leaving Evansville a paddle-wheel bearing ran hot. Shaft diameter was 8 in., and the bearing and crank had three large grease cups. On watch, the Striker Engineer goes out over the water on the fantail boardwalk to those bearings on either side of the paddle wheel. He screws down on the grease cups after feeling the bearings. She kept getting hotter even though she had plenty of grease. We had to continue playing a water hose on her to keep her under control.

"Reaching Lock No. 5 at Freedom, Pa. with that hot bearing, we hit a rock in the river bottom. That tore out our starboard ash well. This is a 12-in.-diameter pipe leading from the water pan under the firebox grates right through the boat's bottom. We commenced taking water so the mate and I grabbed comforts off the officers' beds then got down into the hull and wedged the comforts into the hole.

"My Striker opened the steam siphons that are used for bilge pumps on river boats. Siphoning kept the hull from flooding as we worked. While cramped in the shallow hull, sloshing around in water, the steward kept yelling his lungs out at us down the hatch. He was raving about our using his new-

UNCERTAIN OPERATING COSTS BOTHER YOU?



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REDUCE YOUR INVENTORIES, END CONFUSION

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You never see scenes like the one above in plants that have standardized on R/M's Big 7 Packing Types. For this basic line of just seven packing types has simplified the whole packing problem. With it—and you probably need only three or four of the seven types—you can get custom-built performance for all but your very rarest applications. And because you can, you'll lower inventories, simplify ordering, cut investment costs—and greatly reduce any chance of error through wrong selection. To find out in detail how this line can help you, ask your R/M distributor for a copy of the R/M Big 7 Recommendation Chart.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M Packings for maintenance purposes are sold only through authorized R/M distributors

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PACKING DIVISION, PASSAIC, N.J.

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MARMADUKE

Continued from page 182

est comforts instead of old ones. That's a steward for you every time. But we stopped the leak and went on to Pittsburgh without losing too much time.

"Back safely in Pittsburgh, I planned going to the East coast and signing on a deep-sea ship for Africa or some other quiet place where malaria and leprosy are the only things to worry about.

"When the line's superintendent came aboard, I told him to have my relief aboard next day by noon because I was shoving off. I'd stay until then to see the boilers were cleaned and the boat ready to turn around for the next trip.

"By next morning the boilers were washed and ready to close up. Then one of the boiler-cleaning men, a hillbilly from Tennessee, got a leg caught between the tubes in a boiler and couldn't get out. The harder he tried to free his leg, the more it swelled.

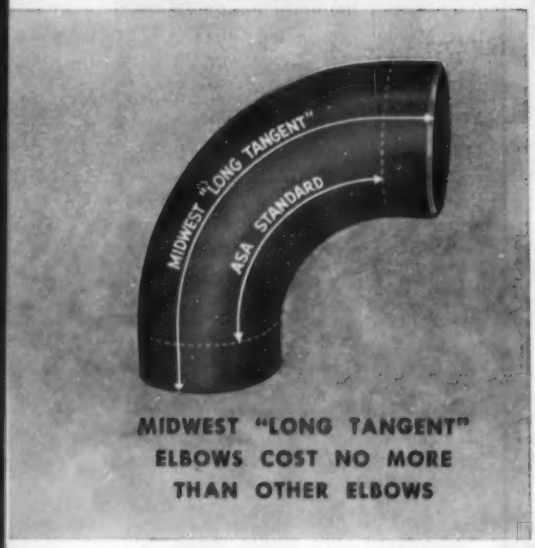
"The Captain sent ashore for a doctor, but he found it too hot to stick around. He looked into the boiler, shook his head and said, 'That's not a medical problem, Chief, that's a mechanical problem. I can't shrink his leg but you can remove a few tubes to free him.' Then he shoved off, wiping the sweat from his forehead and neck. By then the hillbilly was scared stiff. His moaning could be heard all over the boat.

"The Captain came below and told me I couldn't leave until that guy was out of the boiler; he was my responsibility. I could see this was a problem in human engineering, and problems never stop me. Standing near the boiler's man head, I yelled to my Striker Engineer, 'Hand me that fire ax, Murphy. I'll have him out of there in no time—I'm chopping off his leg.' That did it. I don't know how, but the next second that guy shot out of that boiler like a loose piston. He had turned chalk white and beads of sweat rolled off his face as he stood there with his knees knocking.

"By then it was about noon so I got out of the fire room, packed my bag and left the *Aliquippa* in a hurry before something else went wrong. After taking in a high-class burlesque show I bought an evening paper and went into a sea-food restaurant to take on bunkers before catching the night train for New York. But what did I see on the front page but a photo of the *Aliquippa*, showing her sunk on her side alongside the barge landing. The article explained that the tough-luck boat got tired while coaling and decided to take a rest on the bottom."

Marmy stopped talking and got a

THESE MIDWEST "LONG TANGENT" ELBOWS SAVED $4121 IN PIPE



MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

Here are 1227 Midwest "Long Tangent" Elbows (12", 14" and 16" standard weight) ready for shipment to a chemical plant. Each Midwest "Long Tangent" Elbow has a straight section on each end equal in length to ¼ the nominal pipe size. Thus a 12" elbow saves 6" of 12" pipe while a 16" elbow saves 8" of 16" pipe. It doesn't take long to save a lot of pipe and a lot of money . . . in this instance $4121.

But saving pipe is not the only advantage of Midwest "Long Tangent" Elbows. They often eliminate short nipples and their extra welds . . . save time and money in lining up and clamping pipe and fittings . . . slip-on flanges are more easily applied. For all the facts, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic, Los Angeles and Boston

Sales Offices
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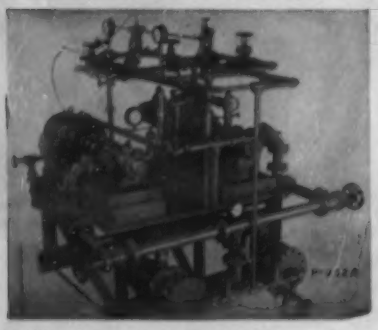
MIDWEST WELDING FITTINGS

MIDWEST WELDING FITTINGS Improve Piping Design and Reduce Costs

NATIONAL AIROIL

SERVING INDUSTRY'S COMBUSTION REQUIREMENTS FOR 43 YEARS

NATIONAL AIROIL
FUEL OIL PUMPING and HEATING UNTIS



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

Complete range of sizes and models in both medium and high pressure types . . . more compact than ever! Write for Bulletin 40

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COMBUSTION ACCESSORIES

AIR CONTROL DOOR and FRAME

FUEL-OIL SUCTION STRAINER

WIDE VIEW PEEPHOLE

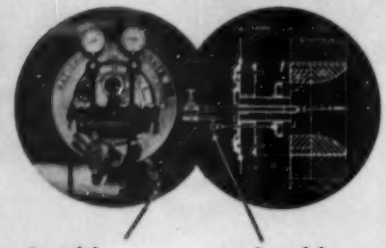
IGNITION PORT

FURNACE RELIEF and ACCESS DOOR

FUEL-OIL HEATER

These and other "accessory items" for every industrial liquid fuel-gas installation. Ask for Brochure No. 10.

NATIONAL AIROIL
UNIVERSAL REGISTERS with TYPE "SA" OIL BURNERS



Control for Air Vane — Control for Refractory Faced Disk

BETTER PERFORMANCE with NATIONAL AIROIL Universal Registers because they have a DUAL FEATURE for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disc control. Both adjustments can be made while the burner is firing.

Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil. Universal Registers with burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.

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STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
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LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
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COMBINATION GAS & OIL BURNERS
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SPECIAL REFRACTORY SHAPES

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

MARMADUKE

Continued from page 184

strangle hold on his bottle of Sandpaper Gin, then worked up a vacuum and started ballasting his tanks. After coming up for air, he roared, "If you young squirts think you're power engineers because you waded through a stack of books in school, give them the deep six. Then get on a river boat for a few years. If that don't teach you to use your head and hands and help you soak up some human-engineering know-how, nothing will. And don't you ever forget about human engineering —because you can't make home port without it."—*SME*

Marmy's Mailbox

IRASCIBLE BUT RESOURCEFUL

I really enjoy that irascible but resourceful character Marmaduke. Only trouble is that, like eating peanuts, it's difficult to stop before the supply is exhausted. I hope, for POWER readers, that Marmy lives a long time.

P VANDERFEER *Centerport, N. Y.*

STORIES ARE TOPS

Marmy is read first when POWER reaches our plant. His stories are tops. I've known characters like him around power plants. Guess that is the reason his stories are so good.

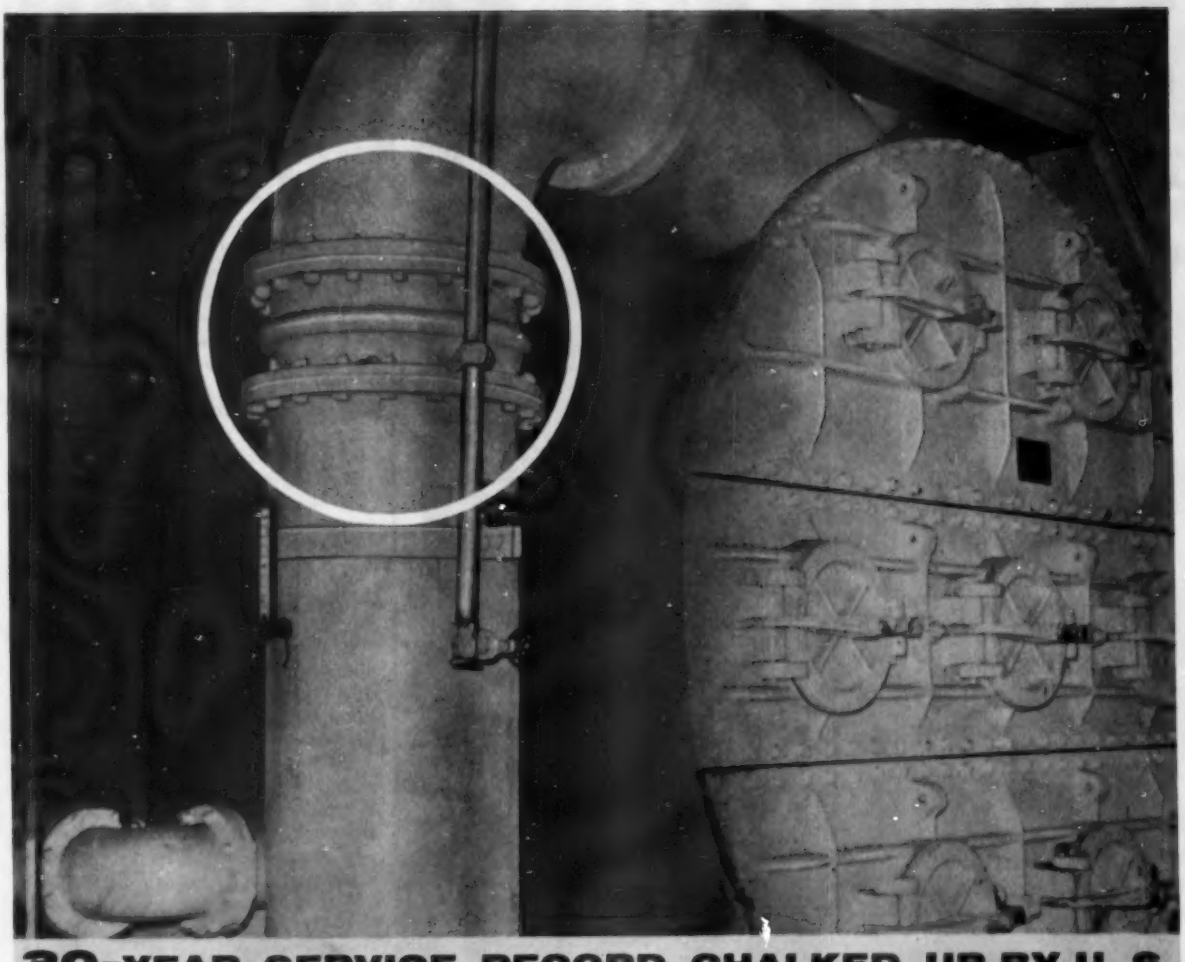
K M WHITE *Chamois, Mo.*

MORE POWER TO MARMY

Marmy's "seat-of-pants" test in Jan POWER was certainly enough to expose the faker, but I hope readers won't use his method alone for judging adequate insulation. So many variables enter into insulation surface temperature—ambient air velocity and temperature, proximity of other heated equipment and structural members, etc. Calculation of economical thickness, when fuel conservation is the insulating objective, is the only sound method of measuring insulation adequacy. A comparison might be made with seat-of-the-pants aircraft navigation against instrument flying.

The old consulting engineer's story is far from fiction though. Aside from the outright frauds, there are well-intentioned neophytes who introduce alleged insulations in all forms from paint to plastics, many of them hailed as "miracle" products to replace all existing materials. Some editors and not a few engineers are taken in by these glowing claims. So I say more power to Marmy for exposing this practice.

BOB NATHANS *New York, N. Y.*



30-YEAR SERVICE RECORD CHALKED UP BY U. S. EXPANSION JOINTS IN WEST COAST POWER PLANT

Above is one of 12 U.S. Expansion Joints installed 30 years ago in a California utility plant. Despite their age these joints are still functioning.

U. S. Rubber Expansion Joints are economical, flexible connections used in pipe lines to take up the stresses due to vibration, expansion and contraction. They prevent the transmission of noise, and take care of misalignment. They have no moving parts to wear or bind and thereby shorten service life.

U. S. Rubber Expansion Joints can be installed on both new and old piping and equipment. These joints plus engineering service are available through any of our 27 "U.S." District Sales Offices, or write address below.

"U. S." Research perfects it...
"U. S." Production builds it...
U. S. Industry depends on it.

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UNITED STATES RUBBER COMPANY
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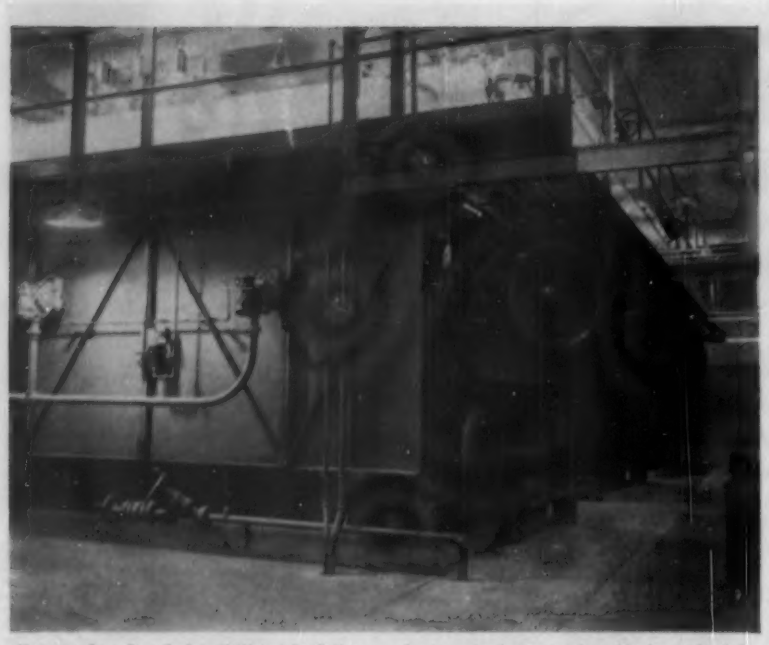


Here are three Bros Packaged Watertube Boilers on the line at the Bell Aircraft, Kenmore, N. Y., plant. Steam generated is used primarily for heat, some for processing. Maximum load is 28,000 lbs. of steam per hour at 50 lbs. pressure during winter months.

Solve steam problems quickly with BROS packaged boilers

● If you are planning a new plant . . . expanding . . . or replacing an old system, find out about the new Bros Packaged Boiler. Bros offers a compact, highly efficient unit, completely factory assembled and ready for simple service connections at the building site. The packaged units are primarily for medium loads; however, in multiples they replace the larger custom units and in so doing eliminate great expense.

No extended work interruptions or erection problems are encountered when you install a Bros Packaged Boiler. It can be lifted or skidded into place. Costly foundations and accessories are not required.

Bros Packaged Boiler capacities run from 4,100 to 30,000 lbs. of steam per hour with design pressures up to 600 psi. Available with or without burning equipment, oil and/or gas. Choice of manual, semi-automatic or fully automatic controls.

WRITE FOR YOUR PERSONAL COPY OF THIS NEW CATALOG

This colorful catalog contains design features, construction details, drawings and specifications of Types W-1, W-2 and W-3 Bros Packaged Boilers. Get your copy for reference or file now!

***POWER DIVISION*—WM. BROS BOILER & MFG. CO.**

1057 Tenth Avenue S.E. BROS Minneapolis 14, Minnesota

DESIGNERS AND MANUFACTURERS OF WATERTUBE BOILERS, 2-3-4 DRUM AND PACKAGED DESIGNS, AUXILIARY EQUIPMENT, AND A FULL LINE OF INDUSTRIAL STOKERS.

APTITUDE TESTS

Continued from page 109

2. Mechanical ability. Bennett Mechanica Comprehension Test is excellent for selecting people who must understand mechanical principles. Test includes those who are to learn new operations, repair and maintain equipment, become skilled mechanics, supervise operators of all kinds of machines.

3. Numerical ability. Many jobs require measuring and computing with speed and accuracy. Short, practical arithmetic tests, such as PTI-Numerical Test, measure an ability needed by mechanical or electrical workers in a short training program, as well as in formal apprenticeships.

4. Manual dexterity. Such tests may help weed out inept persons and help predict skilled workers.

As a minimum and practicable program, you power managers might screen applicants by a short mental-ability test, a mechanical comprehension test and, for some, a test of numerical ability. Program would take 30 minutes to an hour. Besides tests named, there are others.

Starting test program. 1. Consult with personnel department. 2. Secure a qualified personnel psychologist as consultant. Call department of psychology at a nearby university, or write American Psychological Assn, 1333 Sixteenth Street, NW, Washington 6, D. C. 3. Send a staff member to personnel institute, operated by one of the universities, by organizations like American Management Assn or Society for Advancement of Management. 4. Organize a one-day institute of fellow power men in your area. Choose a personnel psychologist as conference leader. 5. Employ someone who has completed courses in industrial psychology and in testing, had experience under an industrial psychologist. 6. If these ways are not feasible, begin modestly with simple tests of the kinds mentioned here. Learn by doing and by studying some standard books on personnel testing.

Warning. Because tests seem so simple and so objective, there's danger of treating them lightly. Also, they may be substituted for some tried and true methods. Remember: tests are *part* of a complete selection process, not a *substitute* for any of its parts. Tests can increase percentage of right selections, but won't solve *all* problems nor will individual predictions always be *right*. They help improve labor force, pay their way quickly.

Costs. Test materials rarely cost more than 50 cents per candidate. Real cost is in persons who administer and interpret them. But since some appli-

NOW JUST ONE GREASE

does practically every grease job in your plant!

Improved

POCO HT Grease

is ideally suited for applications subject to extreme temperatures, moisture, speed and load. Here's why:

- It has a higher melting point than most special "high temperature greases."
- It can be pumped at temperatures as low as –20° F.
- It lubricates completely under conditions of moisture or water.
- It has higher oxidation stability for on the job.
- It provides extremely high protection against rust and corrosion.

Let your local Pure Oil representative tell you how improved POCO HT can cut lubrication costs for you. This may be the only grease you need in your entire plant. Why not call now and find out?

Now it's easier than ever to

"SIMPLIFY AND SAVE"

With improved POCO HT headlining Pure's Multi-Purpose lubricants, you can now save more than ever with Pure's "Simplify and Save" Plan. Find out how it will work in your plant. Write for full literature. The Pure Oil Co. 35 E. Wacker Drive, Chicago 1, Illinois.

Be sure with Pure

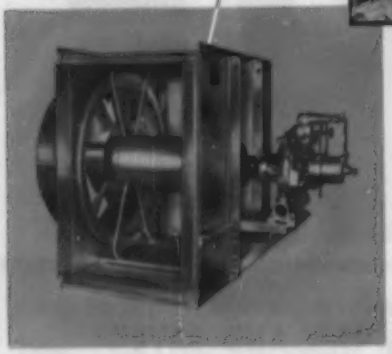
PURE

PURE MULTI-PURPOSE LUBRICANTS

Sales offices located in more than 500 cities in Pure's marketing area.

SPACE PROBLEM SOLVED BY WING PACKAGED POWER PLANT DRAFT INDUCER

Showing Wing Draft Inducer installed as elbow in breeching.



WING POWER PLANT DRAFT INDUCER
May be Turbine or Motor-Driven. Fan and bearing assembly may be withdrawn from housing for inspection and servicing.

at BALLANTINE'S
one of the country's leading breweries

At P. Ballantine & Sons, Newark, N.J., a 70,000 lb./hr. boiler was installed with forced draft supplied by a Wing Turbine Blower. A 200-foot stack served this and one other boiler. Lightning removed 30 feet of the stack making the chimney draft inadequate. Conventional fans, because of large space requirements, would not do. A Wing Packaged Draft Inducer was installed in the existing breeching with no major changes and within the available space. *More facts about Wing Draft Inducers in Bulletin I-55. Use the coupon.*

L. J. Wing Mfg. Co.
50 Vreeland Mills Rd., Linden, N.J.
Factories: Linden, N.J. & Montreal, Can.

L. J. Wing Mfg. Co., Linden, N. J. P-9
Please send me bulletin on WING DRAFT INDUCERS.
Name.....
Firm.....
Address.....
City..... Zone..... State.....

Wing

APTITUDE TESTS

Continued from page 188

cants can be screened out before expensive interviews at higher level, testing costs are offset by reduced time. Choose best tests for job; difference of few cents per applicant in test materials is trivial.

Avoid "package deal." Because many personnel men look for a simple solution, some test authors and publishers have fixed programs. They tell potential user that "complete services" will not need much thought. Package program may suggest there are exact minimum scores, which can be used for all firms. This is scientifically unsound.

Honest test specialist says tests should improve selection, other things being equal. It's best to employ higher-scoring applicants, but "cutoff scores" on test will vary with companies, with labor market, and with other requirements for job not measured by tests.

A reputable psychological consultant presents you with tests and an advisory manual. He tells you to use your head, figure things out, get help if you need it but, above all, avoid the cookbook approach to personnel testing. Aptitude tests, chosen and used wisely can help you select and utilize your manpower. Thus, you effective managers of men can be more effective managers of power.

EDITOR'S NOTE: *Want more information on testing? Please write us your needs and thus help us plan articles.*

MODERNIZING

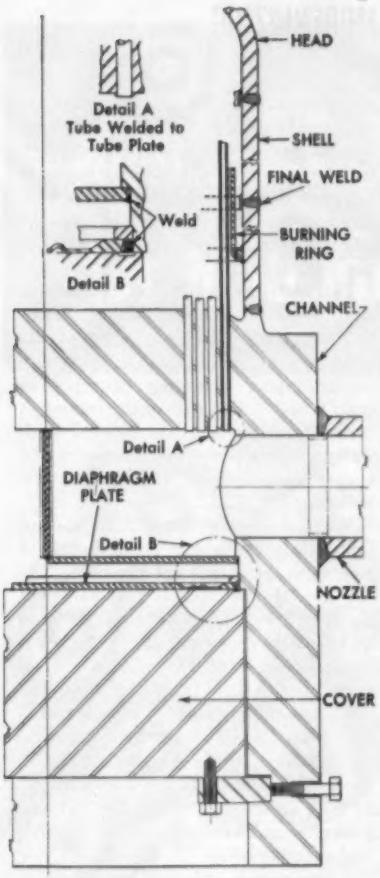
Continued from page 74

kw, the total investment to $6,662,100, or $104 per kw. Adding unit 6 and boiler 23 increased the plant's one-hour capability to 83,000 kw, the investment to $9,588,000, or $116 per kw.

Installing unit 7 and boiler 24 raised the plant's one-hour capability to 110,000 kw, the investment to about $13,723,000, or $125 per kw. Incremental unit cost of developing the station's capacity from 37,000 to 110,000 kw is about $121 per kw capability.

During the five years prior to 1950, Moline Station averaged an annual output of 130,442,000 kwhr at an average heat rate of 18,932 Btu per kw hr. With the completion of Unit 7 and boiler 24, it is expected that the plant's annual output will exceed 400,000,000 kwhr. Since this station is capable of carrying electrical demands in excess of 54,000 kw with 825-psig 900-F units and 19,000 kw with a 825-psig 825-F unit, average annual station heat rate will be about 13,900 Btu per kw hr.

Power costs reduced. Over-all effect



now... an all-welded, bottle-tight FEEDWATER HEATER, by FW

THE standard line of Foster Wheeler high-pressure feedwater heaters has now been supplemented with a new *all-welded* design. By eliminating all bolted and gasketed joints, the danger of leakage under thermal shocks is entirely avoided. This means quick start-ups with no need to control the rate of expansion.

Details of the welded shell-to-channel joint, tube joints and diaphragm construction of the new design are shown in the drawing above. All of these welds have been successfully field tested for several years and the design is now available for regular production.

If you have ever been troubled with heater gasket leaks and gasket maintenance, it will pay you to look into this bottle-tight, all welded heater. For detailed information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW WAY TO

REDUCE STEAM COSTS

AND INCREASE PRODUCTION

☐ Here is a new steam trap that meets all operating conditions!

The Strong Hydro-Flex Steam Trap performs efficiently under light loads yet gives the same high standard of performance under heavy flow, also greater discharge capacity when needed.

We guarantee your steam system will improve with Hydro-Flex. Outstanding plus-features include: a dual fulcrum arrangement that snaps the valve wide open to give unrestricted condensate flow, all stainless steel working parts including one piece deep-drawn stainless steel bucket. The rugged construction features of Hydro-Flex provide long service life with minimum maintenance.

Your local Strong distributor will give you complete information or write us for Bulletin No. SS-40.

STRONG, CARLISLE & HAMMOND COMPANY
1392 W. 3RD. STREET • CLEVELAND 13, OHIO

STRONG HYDRO-FLEX STEAM TRAPS — high efficiency under all condensate loads

HORIZONTAL TYPE SERIES
Hydro-Flex traps with horizontal inlet have the same features as bottom inlet types.

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.

3 types available for wide range application . . . to meet pressure and capacity requirements.

PRESSURE REGULATING VALVES

are custom sized for job demands. Bolted body permits non-threaded seats and wide selection of seat sizes.

BLOW-DOWN VALVES

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

MODERNIZING

Continued from page 190

of modernizing this station is to reduce total cost of power generated about 2 mills per kwhr. This cost reduction is based on annual fixed charges of 13%, increased operating and maintenance cost of $80,000 resulting from the added capacity and fuel costing 27¢ per million Btu.

Full station capability of 110,000 kw can be developed with about 14,137 Btu per kwhr heat rate. Most of the reduction in station heat rate is due to the higher operating efficiency of units 6 and 7. But part of the reduction comes from the increase in final feedwater temperature of the older units and higher operating efficiency of the new boilers.

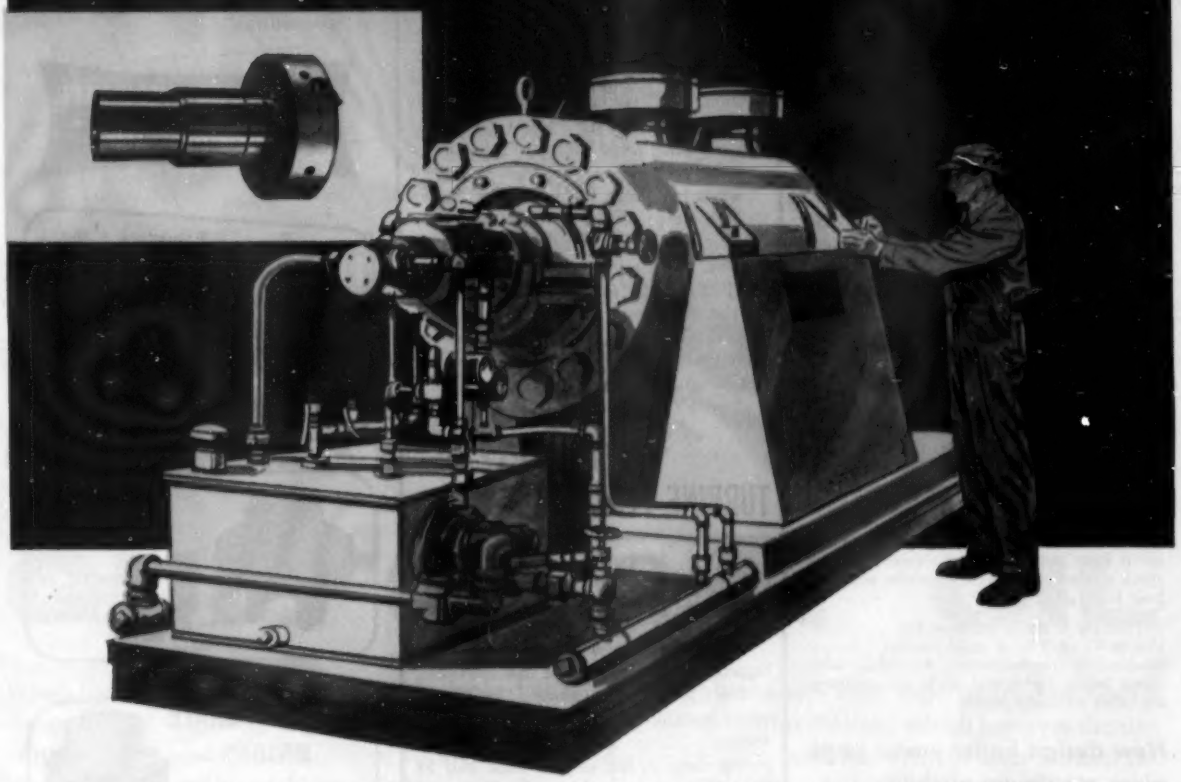
When operating on the high-pressure units alone, with the low-pressure in reserve at an output not exceeding 73,000 kw, Moline Station heat rate will be 11,877 Btu per kwhr compared to 14,137 Btu per kwhr for full-station capability of 110,000 kw, as shown in the table.

Considerable savings were also realized from United Power Pool capacity-equalization credits by good planning during installation of unit 6 and boilers 22 and 23. Removing all ten 200-psig boilers would have reduced the accredited capacity of the plant to 36,212 kw. For this reason only the boilers necessary to provide space for boilers 22 and 23 were removed. Keeping the remaining old boilers in service increased accredited plant capacity to 43,449 kw. Accrued saving from increased accredited plant capacity for the period from May 1951 through July 1953 was $185,629 in United Power Pool capacity-equalization credits. Remaining 200-psig boilers were removed in July 1953 to provide space for boiler 24, and for the service building addition at the east side of the old boiler house.

Effects of Unit No. 7. Relative value of Moline Station, after installing unit 7 and boiler 24, was determined in terms of investment and operating efficiency of the plant as it existed in 1950. Assuming an annual capital cost of 13%, fuel cost of 27¢ per million Btu and increased operating and maintenance costs resulting from the new equipment, $80,000 per year, the relative value of the station in terms of the 1950 plant is $176 per kw. Since no allowance has been made for the difference in dollar levels, the $176 per kw represents a minimum value. If this adjustment is made, the value will increase to about $225 per kw.

Boilers removed. It can also be shown that if the ten boilers had been removed and not replaced and a new

Now... BJ mechanical seals for high pressure boiler feed pumps!



Another Byron Jackson first!

- **No operating adjustment**
- **Stop liquid loss**
- **Reduce heat loss**
- **Save downtime costs**
- **Cut replacement costs**

BJ . . . the pacemaker in mechanical seals for pumps . . . now has pioneered the first successful application of the mechanical seal to high pressure boiler feed pumps. These new BJ Mechanical Seals are now in operation in a number of high pressure, hot water pumping operations, including temperature up to 430° F. These seals—some in service as long as three years—have paid off in performance. They have minimized heat and liquid loss, eliminated frequent repacking problems, and simplified maintenance since no operating adjustment is required. Find out how these new BJ Mechanical Seals for boiler feed pump service can benefit you. Contact your nearby Byron Jackson office or write.

You'll do better with BJ

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Jerguson
TRUSCALE
Remote Reading Gages

Available with Explosion-proof Illuminators

Full 180° Visibility
Accuracy to ½ of 1%

You get full 180° visibility with the new Jerguson Truscale Gages with the Convex Scale. Scale markings are directly on the convex face and the indicator goes clear around the convex surface. You can bring your liquid level down to the control room floor, or other remote point . . . and can see it from anywhere in the room . . . can check a whole line-up of Truscales with one look from any point.

Truscale is really accurate too . . . sensitive to ½ of 1% of scale reading. Simple trouble-free construction. Available with signal horns, lights and up to six repeaters for other auxiliary points.

New design boiler water gage gives maximum visibility

Jerguson's unique offset single piece gage chamber gives you more inches of visibility with no blind spots. Special valve with horizontal loop keeps the strain off the gage under varying conditions of expansion and contraction.

Send for complete data on Jerguson Convex Scale Truscales . . . and Boiler Water Gages.

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100 Follsway, Somerville 45, Mass.

Offices in Major Cities
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

MODERNIZING

Continued from page 192

station designed to provide the additional capacity at a net station heat rate of 9500 Btu per kwhr, a maximum investment of $165 per kw could be justified. This investment takes into account fuel savings from generation displaced at Moline and Riverside Stations with no allowance for any increased operating and maintenance costs.

As of now, a station of high efficiency to meet operating conditions of the Quad-Cities load would cost $190 to $200 per kw of capability. Because design standards and operating practices have changed considerably since Moline Station was constructed, from 1906-1942, a comparison of this type is significant only as it indicates how effective the modernization program was.

When installation of unit 7 and boiler 24 was completed in Dec 1954, the 110,000-kw capability of Moline Station combined with that of Riverside made 250,900 kw of steam capacity available to the customers of the Iowa-Illinois Gas & Electric Co, in the areas of Davenport, Iowa and Rock Island, Moline and East Moline, Ill.

TURBINE-TYPE PUMP

Continued from page 121

gear because the speed of the power takeoff is too slow for efficient pump operation.

Installation precautions. Because liquefied-petroleum gases are unstable, a few precautions should be taken when installing turbine pumps for this service. These are: (1) Locate the pump close to the supply tank and as far below it as possible. (2) Slope the suction line down toward the pump. (3) Avoid right-angle turns and sharp reductions in the suction line. (4) Thoroughly clean suction and discharge lines before connecting to prevent welding slugs or pipe scale from passing through the pump. (5) Use valves that permit straight-line flow. (6) Use ample-size suction lines.

Of the six requirements the size of the suction pipe is the most important. It can give trouble in the best installation if it is so small as to cause excessive friction and high velocity. A temperature rise of a few degrees or a pressure drop of a pound may vaporize the liquid before it reaches the pump if the suction line is improperly sized. For best results, have pipe sizes large enough to keep liquid velocity below 3 ft per sec. The table lists pump ca-

Catawissa
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!

Standard & Double Extra Heavy
UNIONS
Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS
With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS
With screwed or socket weld ends. 3000-lb. and 8000-lb. service.

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showing the complete Catawissa line of Perfect Seal products

CATAWISSA VALVE & FITTINGS COMPANY
206 MILL ST. • CATAWISSA, PA.

West Penn Power Company selected Gulfcrest Oil to lubricate this 140,000 kilowatt unit on the basis of its outstanding performance in the other turbines at their Springdale, Pennsylvania Plant.

—they looked at the record and again selected

GULFCREST OIL

When the West Penn Power Company looked at the record of Gulfcrest Oil in its seven turbine units at Springdale, the choice of lubricant for Number Eight was no problem—Gulfcrest again!

Here's what the record showed: In each of the seven units the original fill of Gulfcrest had been in service for years without any significant changes in its characteristics. And of course the turbines operated continuously and dependably during this period.

A record like this did not just happen. It is the result of careful selection of crude oils that are thoroughly refined, then super-refined by Gulf's exclusive Alchlor Process, which removes the unstable hydrocarbons that remain after normal refining. This discarded portion, if allowed to remain in a turbine oil, accelerates oxidation, increases neutralization number, forms sludge, and harmful acids.

So to insure safe, long-lasting protection for your turbines, specify Gulfcrest—the world's finest turbine oil. Contact your nearest Gulf office today and have a Gulf Sales Engineer recommend the proper grade.

GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

GULF OIL CORPORATION • GULF REFINING COMPANY

1822 GULF BUILDING, PITTSBURGH 30, PA.

Steam or mechanical atomizing...1 to 1000 gallons per hour

Designed for operation with either gas, oil or both with natural or forced draft. They can be depended on for maximum combustion efficiency.

ENCO Interchangeable Oil-Burners can be changed instantly to operate by either steam or mechanical pressure atomizing over a wide capacity range.

ENCO Oil Atomizers are applied to various types of standard pulverized-coal and gas-burner units cold starting or for full load operation when coal or gas is not available, or when oil is the more economical fuel.

Send for Bulletin OB-53 describing ENCO Gas and Oil Burners, also complete Pumping and Heating Units.

EC 808

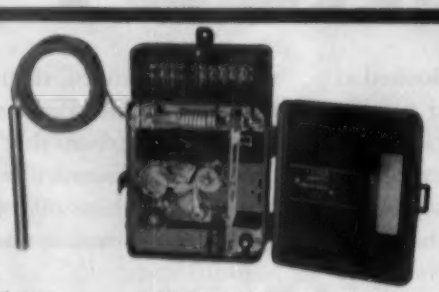
THE ENGINEER COMPANY, 75 West Street, New York 6, N. Y.

BARBER COLMAN

ECONOSTAT INSIDE-OUTSIDE

Zone Temperature Control

SUPPLIES HEAT
IN PROPORTION
TO HEAT LOSS
Automatically



- Regulates heating in multiple-occupancy buildings, based upon changes in outdoor temperature
- Supplies heat at intervals — avoids waste of "overheating" — keeps people comfortable
- Settings for night depression and morning warm-up cycles effect further economies
- Heat-on period measured from availability of heat where needed rather than turn-on of heat source —avoids "heat-lag"
- Often pays for itself in one or two heating seasons with fuel savings— brings untold new comfort
- Motor-operated Zone Control valves used with Econostat are available in all sizes and body patterns

ASK FOR BULLETIN 1647-3

Consult nearest Field Office or write . . .

Barber-Colman Company

DEPT. U, 1351 ROCK STREET, ROCKFORD, ILLINOIS, U. S. A.

TURBINE-TYPE PUMP

Continued from page 194

pacities with pipe sizes to meet this velocity requirement.

Self-priming. An inherent feature of turbine pumps is their ability to handle air or vapor with liquid. This characteristic is common to all pumps of this type, but more so to designs with the discharge at the top of their casing where air or vapor is most easily liberated. To improve self-priming, a separating chamber is usually a part of the pump, as in Fig. 1. This pump also has a trap or chamber on its suction.

For a turbine pump to be self-priming it is necessary to recirculate a small quantity of liquid in its channel, which alternately entrains air at the suction and discharges it into the separating chamber. Some designs depend on gravity to return liquids to the pump channel, while others use centrifugal force for this purpose. In either case, a separating chamber in the discharge opening speeds up (1) removal of air or vapor from the suction line and (2) priming of the pump.

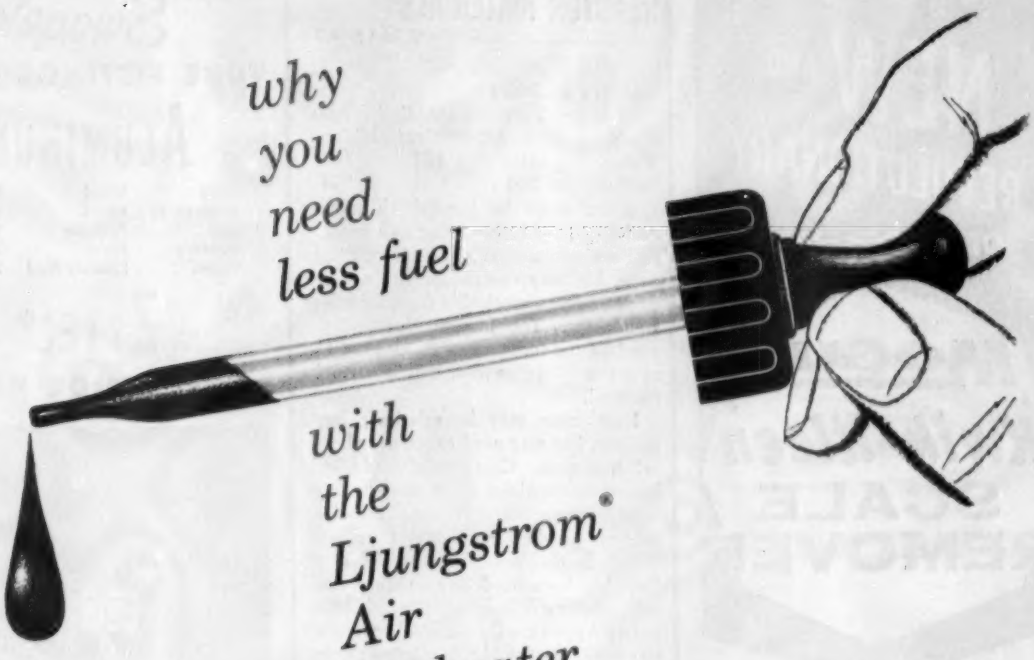
Suction trap fulfills no purpose during priming other than servicing as a small supply tank to keep the pump filled at all times. Where frequent repriming is required, as when pumping out tanks or barrels, the suction trap retains enough liquid in the pump to enable it to pick up its prime, without having to add priming liquid.

On turbine pumps the suction trap often houses a strainer to protect them against the entrance of foreign material, which might damage the impeller or cause rapid wearing of the sealing surfaces. If there is much suspended matter in the liquid, the screen may become clogged and should be removed and cleaned often so it does not restrict liquid flow into the pump.

Vapor handling. The characteristic that makes a turbine pump self-priming also makes it a good pump for handling volatile liquids, such as hot water, light ends of petroleum, and chemicals that vaporize easily under service conditions. Volatile liquids usually flow into the pump from a source above it. If liquid is close to its vaporization point, vapor bubbles are apt to form continuously and must be handled with the liquid, or else the pump will become vaporbound. Vapor bubbles are carried along with the liquid and are released in the discharge line, or chamber, as air is in the priming operation.

Vapor in the suction line reduces pump capacity and causes jerky flow. Whenever a turbine pump must handle liquid close to its vaporization point, place it as far below the surface of the liquid as possible. Thus you get maximum suction head for the conditions.

why you need less fuel with the Ljungstrom® Air Preheater

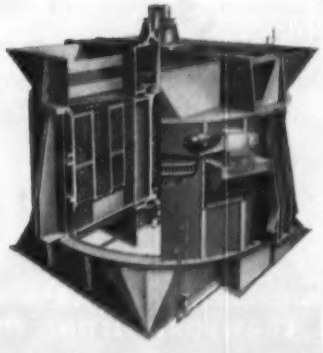


With every 45-50 F of air preheat — you cut your fuel bill 1%. That's why it pays to equip your boilers with Ljungstrom Air Preheaters. For the Ljungstrom is the most efficient air preheater there is.

Advantages of the Ljungstrom Air Preheater

- **Size for size, recovers more heat than any other type.**
- **Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.**
- **Eliminates cold spots . . . keeps corrosion to a minimum.**
- **Easier, faster to clean and maintain.**
- **Requires far less supporting steel and is quickly erected.**

The Ljungstrom also gives industrial plants broad latitude in their choice of fuels. Its unmatched preheating efficiency makes practical and effective such low-grade fuels as saw and paper mill refuse, wood, lignites, peat and bagasse.



Outright fuel economy is reason enough why 7 out of 10 modern preheater installations are Ljungstrom, and why Ljungstrom percentage of installed boiler capacity increases every day. Yet it's just one of the many advantages of the Ljungstrom. Get all the details on why the Ljungstrom cuts fuel costs . . . why it's the most efficient heating surface on the modern boiler . . . why it's easier to clean and maintain. All the details are in the new, 38-page reference manual, "Ljungstrom Air Preheaters." Write for it, today.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

NEW AND REVOLUTIONARY DEVELOPMENT

MOGUL
Kwik-Kleen
SCALE REMOVER

The first truly safe and wholly effective method for rapid scale removal. Proven outstandingly successful wherever used.

Safe for Employees-
Safe for Equipment-

Will remove most stubborn scale deposits quickly and easily from:

- *Evaporative Coolers*
- *Evaporative Condensers*
- *Shell and tube Condensers*
- *Hot water heating Coils*
- *Heat exchangers*
- *Compressors*
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- *Boilers*

Will not irritate or harm the hands and arms, so requires no gloves, goggles or face masks. Give off no harmful, corrosive fumes.

Mogul "Kwik-Kleen" comes in measured moisture proof bags, packed in drums. Dissolve in water — easy and ready to use.

Write today. Tell us about your scale problem.

The North American
MOGUL
PRODUCTS COMPANY
40 years of progress ... and still growing
CLEVELAND 13, OHIO

REACTOR MATERIALS

Continued from page 100

compare as follows:

Fluid	Temperature, F, for equal kinematic viscosities		
Water	115	170	197
Sodium	300	600	800

Water must be treated chemically and deaerated before using as a coolant. Sodium, commercial grade, is relatively pure, but may contain many trace elements, some undesirable from a nuclear standpoint. The foreign elements depend on the sodium source. Oxygen and nitrogen in the sodium will have to be removed.

Raw water may be relatively inexpensive, but may need expensive chemical treatment. Commercial-grade sodium averages about 16 to 18c per lb in large quantities. Three principal sources are du Pont, Ethyl Corp, and National Distillers. Liquid-metal alloy NaK has been used as secondary coolant. Callery Chemical Div of Mine Safety Appliance Co is the sole commercial source in the U.S.A. Current price is about $1 per lb. Future competition will probably force a price reduction. Principal advantage of NaK is its lower melting temperature, usually eliminating need of system preheating equipment before initial charging and during reactor shutdowns.

Water used as a coolant will probably be treated in a demineralizer to keep solids to less than 1 ppm. The water must be held at proper pH level and the dissolved oxygen removed. Since nuclear radiation may produce dissociation it may be necessary to provide recombining equipment at some point in the circuit in which to burn the free hydrogen and oxygen.

Sodium has a high affinity for oxygen and carbon. Oxygen increases the corrosive action of sodium and carbon forms sodium carbide, which precipitates out and may plug flow passages. Oxygen forms sodium oxide, which increases the melting temperature of sodium. Oxygen should be kept to less than 0.003% by weight in sodium. Inert gases to blanket sodium are first passed through a bubbler system to remove traces of water vapor and oxygen to minimize troubles in the radioactive sodium coolant system.

Before installing the fuel and bringing up the reactor to criticality all coolant passages must be thoroughly cleaned.

Thermal insulations in the reactor system will also be exposed to radiation, but their thermal conductivities will not be affected to any serious extent. Choosing insulating materials for gas- or water-cooled reactors depends

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TUBE FITTINGS FROM
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TO Brass, Carpenter 20, Gold, Hastelloy, Inconel, Monel, Nickel, Platinum, Silver, Stainless Steel, Steel, Tantalum, Teflon, Titanium, Zirconium
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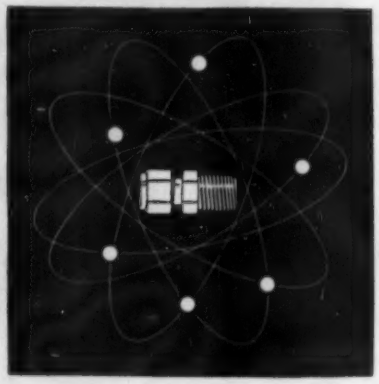
POLYAMIDE RESIN



From aluminum to "Zytel" there's a Swagelok answer to your fitting problems. The new Swagelok Tube Fittings of "Zytel" are for use with plastic tubing in applications where corrosion is a problem. They are the first to be made in a complete range of shapes that include elbows, tees, reducers and adapters.

The new Swagelok Tube Fittings of "Zytel" are made to the unique Swagelok patented design that provides strong, torque-free and leakproof joints at all tubing connections. Sleeves or inserts are unnecessary. Specify Swagelok for every fitting need and eliminate unnecessary fitting problems.

FREE: For complete information write for the Swagelok catalog. Address Dept. E4.

Swagelok Tube Fittings Are
Easy to Use
No Special Tools Needed
No Flaring or Threading

*DuPont trade-mark

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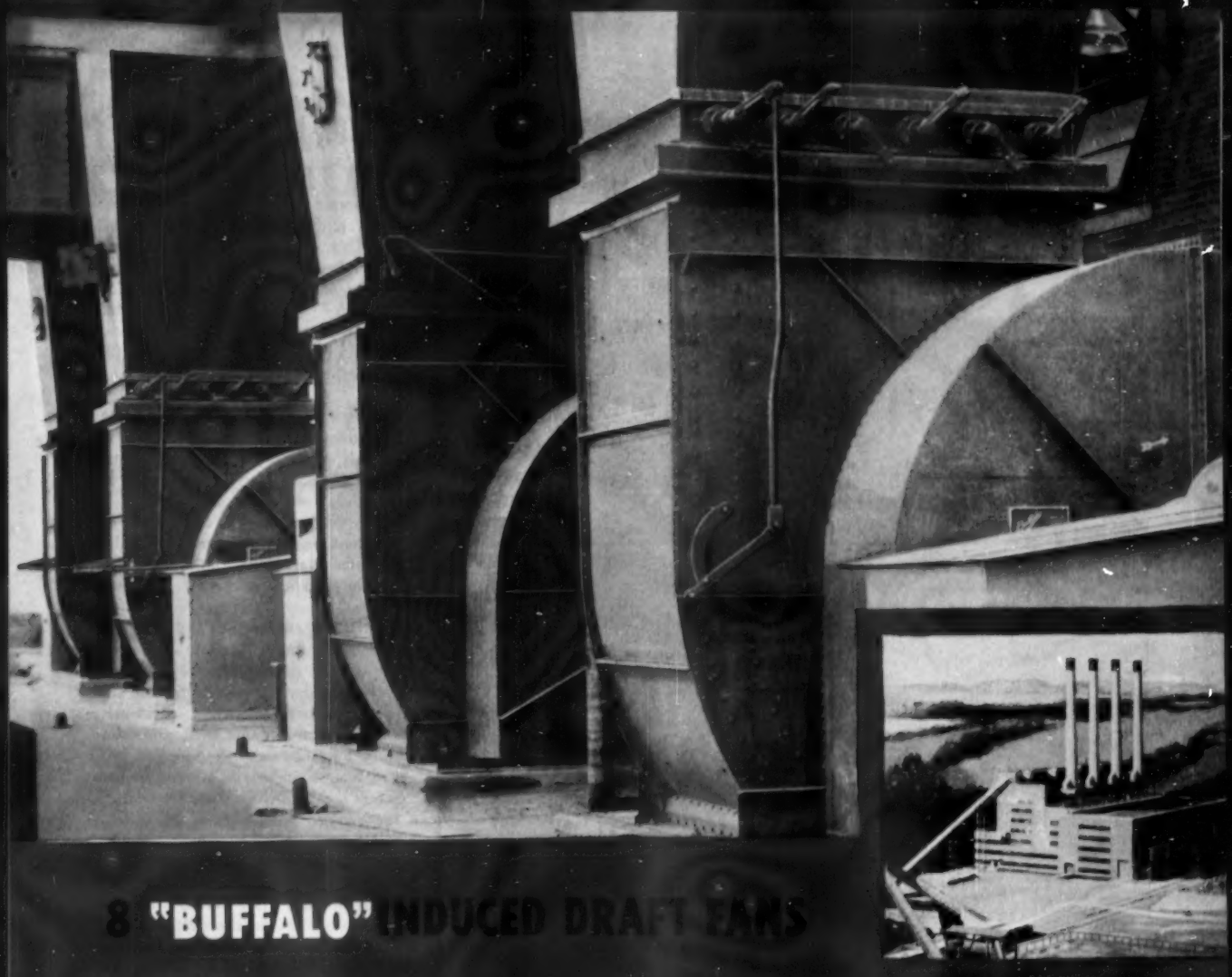

8 "BUFFALO" INDUCED DRAFT FANS

— 2,800,000 lbs/hr of POWER-PRODUCING STEAM

The eight "Buffalo" Induced Draft Fans above serve the four reheat cycle steam generators of the 400,000-kw Wabash River Station of the Public Service Company of Indiana, Inc., above, right. It takes a lot of air to produce power — and the source of air must be as reliable as the fuel. This is why "Buffalo" is the choice for the punishing induced draft job in so many utility stations as well as in industrial power plants. The famous "Q" Factor* of Quality is built into every "Buffalo" Fan. Write for Bulletin 3750 and see why "Buffalo" Forced Draft, Induced Draft, Gas Recirculating and Primary Air Fans give the dependable air delivery your boilers need for top output!

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

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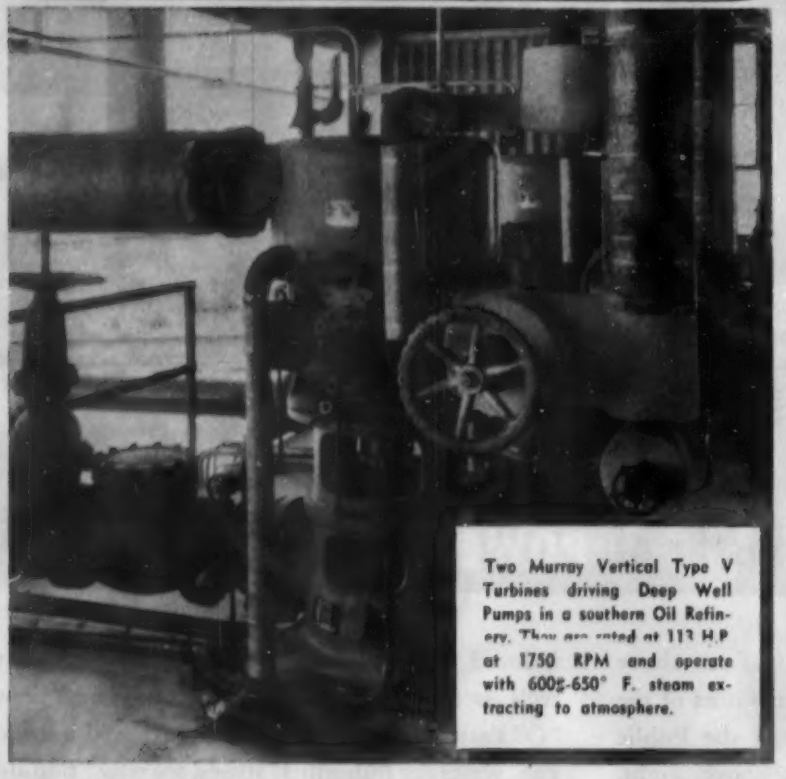
VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Murray Turbines



Two Murray Vertical Type V Turbines driving Deep Well Pumps in a southern Oil Refinery. They are rated at 113 H.P. at 1750 RPM and operate with 600#-650° F. steam extracting to atmosphere.

● Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended". The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

REACTOR MATERIALS

Continued from page 198

on economic evaluations for the temperature conditions. For liquid-metal-cooled reactor systems, insulating materials must be inert to the liquid metal in case of a leak. Some materials satisfactory for liquid-metal systems are: (1) mineral wool—steel or lead mill slag (2) diatomaceous silica (3) reflective metal type.

Electrical insulation. Nuclear radiations affect some electrical insulating materials quite seriously, especially the organic types. Alkali liquid metals attack insulations containing oxygen. In nuclear reactor plants a reliable arrangement uses a sheathed-type cable with mineral-wool insulating material for main electrical and control systems.

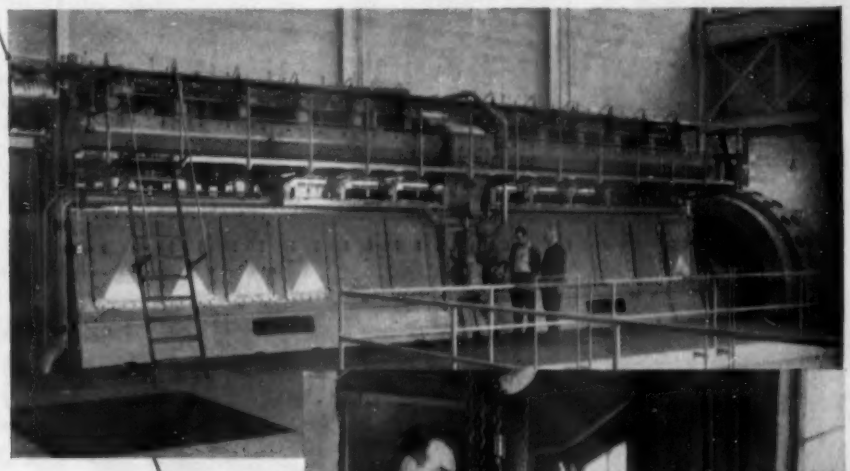
Lubricants containing hydrocarbons break down under nuclear radiation. Some silicone compounds may prove to be stable under nuclear radiation and give satisfactory lubricating service. In thermal-reactor plants hydrogen-containing lubricants can be used if protected from nuclear radiations. In fast reactors these lubricants cannot be used if there is *any possibility* at all of their getting into the reactor directly or being carried in by the coolant. Hydrogen being an excellent moderator might put the reactor on a "fast period" that the control could not handle safely. Other lubricants with no moderating constituents will probably be used in fast reactor plants.

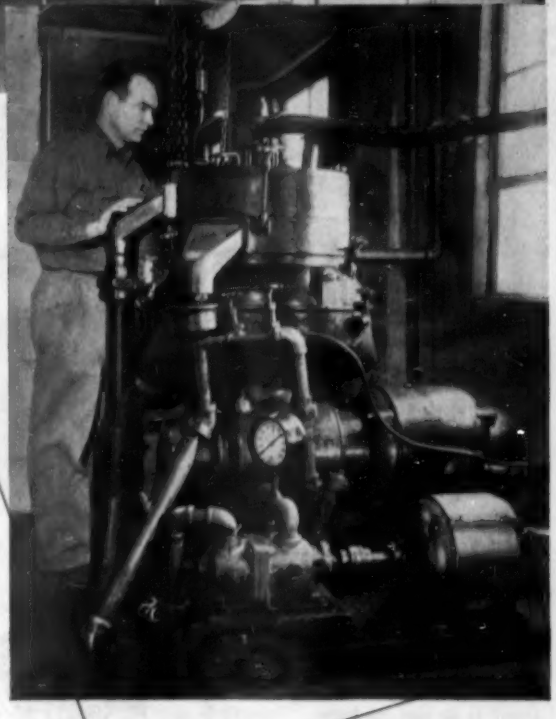
Shielding materials were mentioned in Part 10, May 1955, pp 94-95. In most cases, excepting concrete and steel, the shielding will be protected by a cladding or canning material like stainless steel; the shielding material carries no structural load. The shielding material primarily attenuates nuclear radiations. Both the neutrons and the heat energy generated by gamma rays affect structural strength of concrete—these must be taken into account by the designer. If the coolant contacts the shield, corrosion and mass transport effects must be taken into account. This is another reason for using cladding and canning materials.

Moderator materials, with the exception of light and heavy water, fall in the same category as shielding materials with respect to protective cladding and canning.

Next article will cover coolant equipment components, piping systems, auxiliary systems, and components external to the reactor.

DE LAVAL "NOZZLE-MATIC" SAVES $3,600 IN ONE MONTH!





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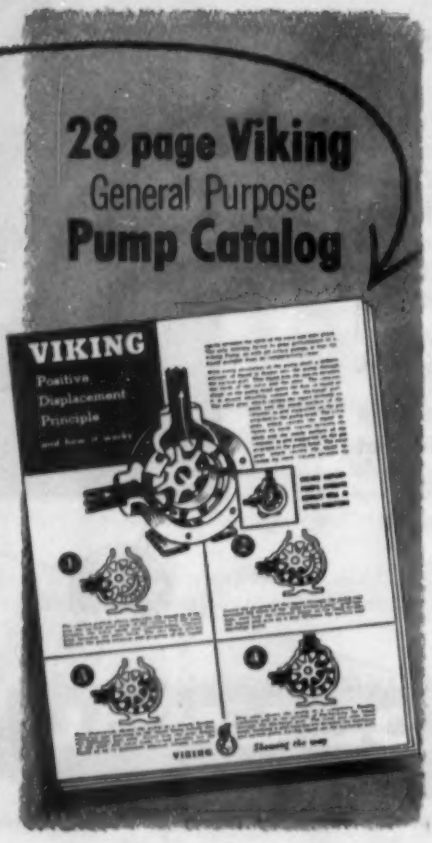

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APPOINTMENTS

Corporation executive changes

Crane Co: Frank F Elliott, president and chief executive officer. **The Allen-Sherman-Hoff Co:** B C Berry, chairman of the board; H E Allen, president. **Bailey Meter Co:** Paul S Dickey, president; Harvard H Gorrie, vice-president, engineering; Raymond D Junkins, vice-president and director. **Midwest Piping Co, Inc:** Eric A Kerbey, president. **Henry Pratt Co:** E B Cottingham, president. **Stone & Webster Engineering Corp:** Russell T Branch, chairman of the board; T Cortlandt Williams, president.

The Fairbanks Co: Alexander L Naylor, president. **Ajax Flexible Coupling Co Inc:** Wayne Belden, president; Charles W Belden, vice-president. **Safe Harbor Water Power Corp:** Frederick W Utz, president and director. **Solar Electric Corp:** Walter J Dremann, president. **The Baldwin-Lima-Hamilton Corp:** McClure Kelley, president.

The Texas Co: James W Foley, executive vice-president. **Dayton Automatic Stoker Co:** Joseph F Stenglein, executive vice-president and general manager. **Bogue Electric Manufacturing Co:** Ken R Gerlach, executive vice - president. **Warner Electric Brake & Clutch Co:** Norman K Anderson, vice-president, sales; King DeSeve, vice-president, operations.

Combustion Engineering, Inc: Theodore A Dyke, vice-president. **Alco Products, Inc:** James J Reynolds, vice-president, operations. **Rockwell Manufacturing Co,** meter and valve div: Paul C Kreuch, vice-president. **Rome Cable Corp:** Glenn Koger, vice-president. **Alloy Precision Castings Co:** Frank W Glaser, vice-president and director. **Allis-Chalmers Manufacturing Co:** William A Yost Jr, vice-president, staff operations.

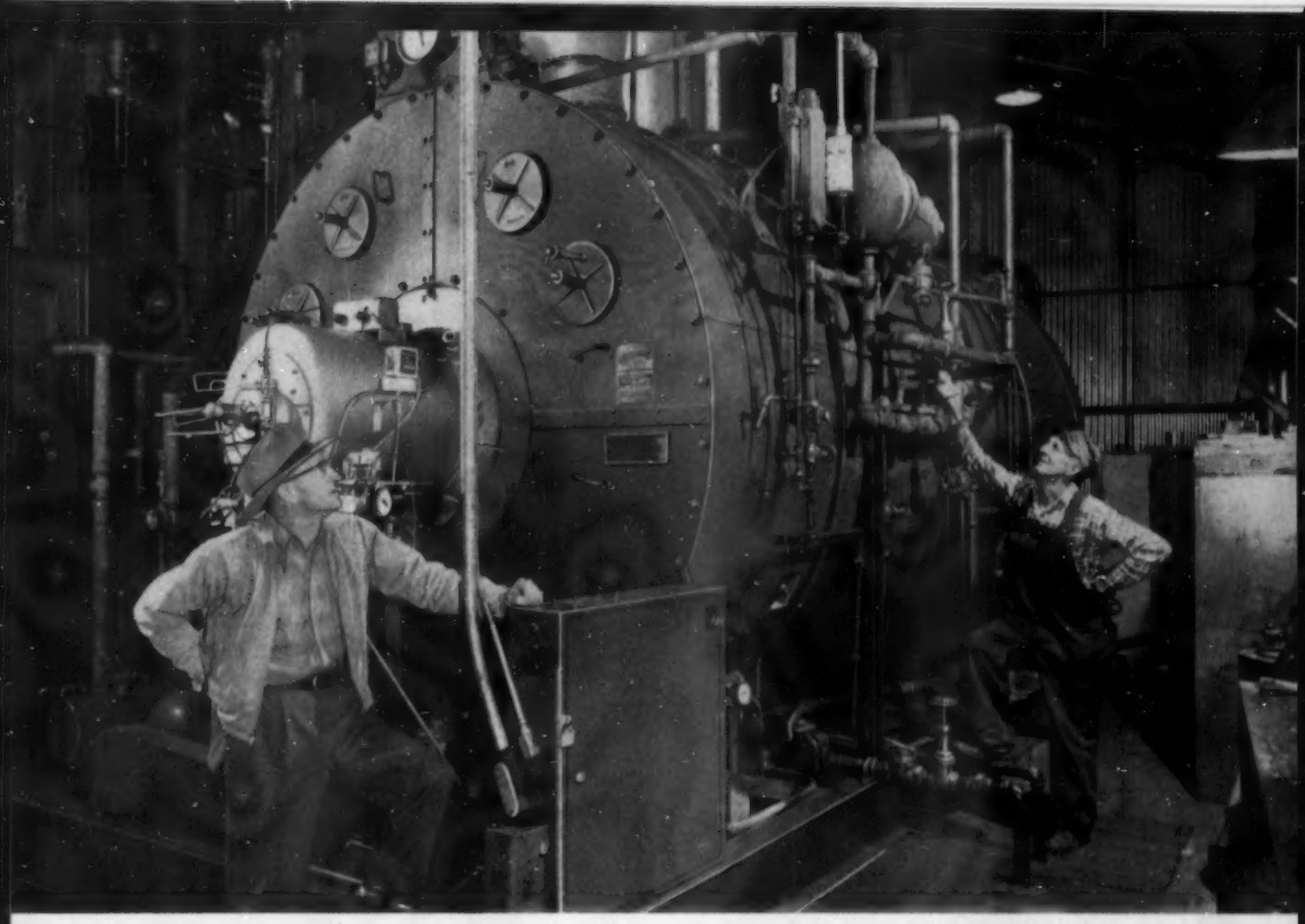
Operations executive changes

Westinghouse Electric Corp: L E Hedrick, Pacific Coast region manufacturing and repair manager. **Crane Co:** George G Lindholm, manager of valve and fitting dept; F J Wilkey, special representative of industrial sales div; T D Kelley, Chicago branch manager.

Mexico Refractories Co: J Paul Maddox, special representative of refractory specialties div. **The New York Air Brake Co:** George H Garraway, director of manufacturing. **Atomic Energy Commission:** David F Shaw, asst general manager for manufacturing. **The Cooper-Bessemer Corp:** James W Reed, Pacific Coast manager.

Engineer changes

Allis-Chalmers Manufacturing Co: Henry Carroll, nuclear physicist in re-



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The reason for these extra sales is because *Powermaster* is solving two steam problems—more steam for processing, and more efficient off-season heating by means of modulating control of firing rate.

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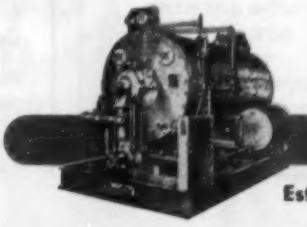
Write for Bulletin 1220 or ask our representative to tell you how *Powermaster* can meet your requirements.



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Conseco and its subsidiaries design, build, and install power and processing equipment and accessories, some of which are listed here. Purchasers of Conseco equipment benefit from our maintenance division's quarter century experience in rebuilding, modernizing, and maintaining our own as well as competitors' equipment. This coordination assures easy accessibility for maintenance and low operating cost. Send for bulletins covering equipment in which you are interested.

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More APPOINTMENTS

Begins on page 202

search div. **Worthington Corp:** Hellmuth Walter, director of research. **Metal & Thermit Corp:** J E Stareck, director of research. **National Electric Products Corp:** Conrad B DeSautels, research and development engineer of wire and cable.

Continental Foundry & Machine Co, Copes-Vulcan div: James D Baker, director of engineering. **Sylvania Electric Products Inc:** Bernard Kopelman, chief engineer of atomic energy div. **Walworth Co:** Newton Ewalt, chief engineer. **Condenser Products Co:** Herbert A Haworth, chief engineer.

The Detroit Edison Co: Edward R Moore, manager of engineering. **Calumet & Hecla, Inc,** Wolverine Tube div: Donald Q Kern, professional consultant in the field of heat transfer. **The International Nickel Co, Inc:** Leon M Petryck, research metallurgist in welding section of Bayonne (N.J.) research laboratory.

New distributors

For **Westinghouse Electric Corp,** Sturtevant div: Hahnel Brothers Co, Lewiston, Me; Strong, Carlisle & Hammond Co, Cleveland, Ohio; McCombs Supply Co, Denver, Colo; and Arco Electric Supply Co, Inc, New York, N. Y.

For **Electric Machinery Manufacturing Co,** Mullenbach div: Worthington Corp, Plainfield, N. J. For **General Electric Co,** Carboloy dept: Austin Ford Logan Inc, 1500 Kenmore Ave, Buffalo, N. Y.

For **Stephens-Adamson Mfg Co,** standard products div: J R Banbury Equipment Co, 295 Saw Mill Run Blvd, Pittsburgh 26, Pa.; Southern Chemical Sales Co, Board of Trade Bldg, Louisville, Ky.; P J Hagerty Equipment Co, 800 S Adams St, Peoria, Ill.; Wisconsin Bearing Co, 915 N Market St, Milwaukee 2, Wis.; Buffalo Rubber & Supply Co, Inc, 526 Niagara St, Buffalo 1, N. Y.; Dabney-Hoover Supply Co, Inc, 45 W Virginia Ave, Memphis, Tenn.; and The Harshberger Equipment Co, 425 SE 9th Ave, Portland 14, Ore.

New representatives

For **Sarco Co, Inc:** C H McGuiness Co, 505 SW 7th St, Des Moines, Iowa; Steam Engineering Service Co, 620 12th St, Denver, Colo.; J B Lammons Co, 1596 Madison Ave, Memphis, Tenn.; and Robert Porter, 224 N Congress St, Jackson 2, Miss.

For **Graver Water Conditioning Co:** Atlas-Misrock Co, 110 N 8th St, Richmond, Va. For **Cleaver-Brooks Co:** Powell Equipment Co, 7623 Greenstone, Houston, Texas; Dykes Co, 1012 Market St, Shreveport, La.; and Barrett & Yost Co, 5600 14th Ave NW, Seattle, Wash. For **Childers Manufacturing Co:** Power Equipment Co, 1352 Madison Ave, Fitzhugh Bldg, Mem-

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economy fuels...
new
engine designs...

there's one answer for all three of these lubrication problems—

STANODIESEL OIL M

Demands upon the lubricant in stationary industrial engines are increasing. More severe operating conditions caused by heavier loads, new engine designs and the use of economy fuels pose difficult lubrication problems not met by conventional oils. Standard Oil Company introduces a lubricant specifically designed to meet these problems—STANODIESEL Oil M.

STANODIESEL Oil M meets or exceeds the requirements of a lubricant for stationary industrial engines. Here's why:

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Special additives are blended with this STANODIESEL Oil M base stock. An oxidation inhibitor prevents unwanted increases in oil viscosity and prevents corrosion of bearings. The action of detergent-dispersant additives keeps crankcase, pistons, cylinder walls and other parts clean. Contaminants are kept in suspension and are prevented from depositing. An anti-foam agent makes this oil suitable for use in hydraulic governors. A wetting agent increases the oil's ability to reach and maintain a film on such highly stressed parts as cams and cam followers.

Use of STANODIESEL Oil M means this: less engine deposits, less ring and cylinder wear. Less spark plug fouling when used in gas engines. Eliminates fuel injector and pump sticking caused by deposits on the injector barrel and plunger when fuel and lubricating oil commingle.

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UNIQUE sectionalized air-cylinders maintain Lower Operating Temperatures, and require LESS HORSE POWER.

THIS design-advance combines with OLD-FASHION ruggedness and AIR-CUSHION valves to place these machines away out in front and they give you LONG, USEFUL LIFE.

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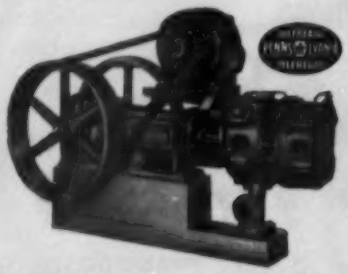

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• Foster Type 38-SV Super-Jet Safety Valves for steam pressures to 3000 P.S.I. and temperatures to 1100°F are designed for boiler drum and superheater outlets, reheater inlet and outlets, and, as a relief or safety valve on soot blower installations, turbines, pressure reducing valve and desuperheater stations.

Foster Super-Jet Safety Valves are protecting boilers at 2700 P.S.I. and 1100°F, and are also in service at pressures as low as 10 P.S.I.

Foster Super-Jet Safety Valves have been selected because of their high relieving capacity, adjustability for minimum blow-down, and consistent popping at name-plate pressure. The outside frame rod construction makes disassembly possible without disturbing spring setting, permitting inspection and relapping of seats during a minimum outage time. Piston freedom can be checked at any time with the valve under pressure.

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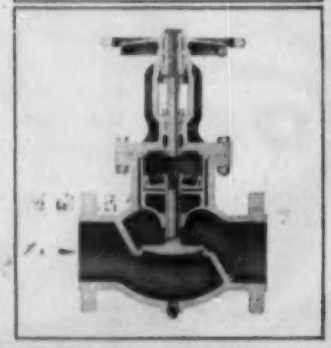
Foster Non-Return Valves have been in service since 1900 and today are installed in major steam plants throughout the country.



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More APPOINTMENTS

Begins on page 202

phia 4, Tenn. and J P Maguire Co, 3144 Paris Ave, New Orleans, La. For **Bulkley, Dunton Processes, Inc:** Backus & Spencer, Cleveland, Ohio. For **Hammel-Dahl Co:** MacGuire Instrument Co, 1200 Axtell Dr (Columbia), Cayce, S. C. For **Cochrane Corp:** Dickey Engineering Co, 2721 Central Ave NW, Knoxville, Tenn.

Recent moves

Steel Founders' Society of America: headquarters to 606 Terminal Tower Bldg, Cleveland 13, Ohio. **De Laval Turbine Pacific Co** to new building at 201 E Millbrae Ave, Millbrae, Calif. **H K Porter Co, Inc,** Leschen Wire Rope div: New York district office and warehouse to 219 Emmet St, Newark, N. J. **Calumet & Hecla Inc,** Wolverine Tube div: new general sales offices at Guardian Towers, Guardian Bldg, Detroit 26, Mich.

Institute, association changes

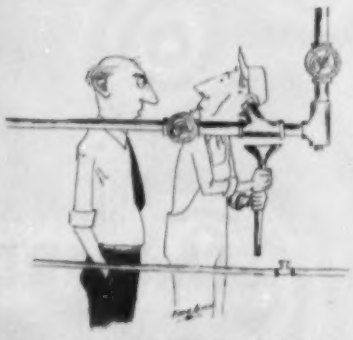
American Nuclear Society: W H Zinn, president; Philip Sporn, vice-president. **American Institute of Electrical Engineers:** Morris D Hooven, president; Bradley Cozzens, Evan R Jones, William J Miller, Cullen T Pearce and B G Ballard, vice-presidents. **American Gear Manufacturers Assn:** Marvin R Anderson, president; Fred R Eberhardt, vice-president.

Battelle Memorial Institute: B D Thomas, David C Minton Jr and John S Crout, vice-presidents. **Copper & Brass Research Assn:** Austin R Zender, president. **National Assn of Fan Manufacturers, Inc:** C C Cheyney, president; R W Nelson, vice-president.

Retirements

Harry A Burdorf, vice-president of Lunkenheimer Co, after 50 years of service to the company.

Arch A Warner, president and general manager of mechanical universal joint division of Borg-Warner Corp.



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In fact, there is a General Cable Varnished Cambric Cable that is *exactly* right for your particular installation. Ask your friendly General Cable representative or distributor for complete information.

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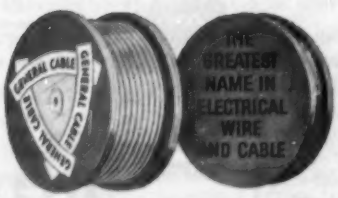

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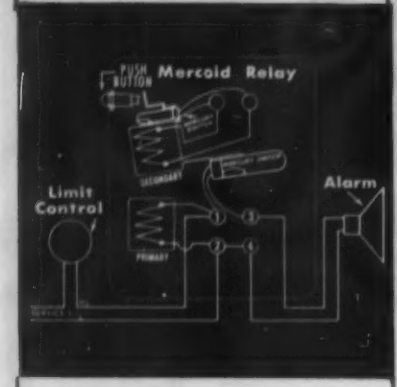
MERCURY SWITCH EQUIPPED

RELAY

for Audible or Visual Alarm



The control which senses the alarm circuit is connected in series with the primary coil of the relay. The alarm control closes its circuit to supply current to the relay primary coil and through the normally closed mercury switch of the relay to the Audible or Visual Alarm. Pushing the manual button of the relay (or through a momentary contact by a remote switch connected to the pilot circuit) causes the secondary coil to move upward, opening the normally closed mercury switch and stopping the Alarm. A lock circuit in the relay holds the alarm circuit open as long as current is supplied to the primary coil of the relay. When the alarm control opens its circuit interrupting the current to the relay primary coil, the magnetic repulsion holding the relay secondary coil up is interrupted and the secondary coil drops from its own weight. The alarm circuit sequence is thus reestablished automatically and is ready for another operation at the demand of the alarm control.

Available for 115, 230 or 440V. A.C. current or similar D.C. voltages.

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More TECHNICAL BRIEFS

Begins on page 150

tive motion of the walls and to varying degrees of eccentricity of the bounding surface. Experimental work was carried up to a Reynolds number, based on diametral clearance, of 30,000 Theoretical results are shown both graphically and in form of equations. Nomographs are included for rapid solution of certain engineering problems.

Future results will assay the accuracy of theoretical analysis and experimental methods in terms of lasting quality. Deficiencies are apparent (thermal, phase-change, etc.) and it is hoped that in lieu of perpetual constancy, the conclusions will stimulate and justify additional work in this field by other investigators. *ASME paper no. 54-A-175.*

Two- and three-dimensional flow of air through square-edged sonic orifices. *By A Weir, Jr, Engineering Research Institute, J Louis York and R B Morrison, University of Michigan.*

In this investigation, two-dimensional flow of air through rectangular, and three-dimensional axisymmetrical flow of air through circular square-edged sonic orifices was examined under pressure ratios ranging from 1.894 to 42.0 (upstream stagnation pressure/downstream static pressure). Mass flow measurements were made using a primary metering system, rather than another orifice or nozzle, and optical techniques were used to obtain pictures of the flow upstream, within the thickness of the orifice plate, and downstream of the orifice.

Evidence is presented in this paper that indicates square-edged sonic orifices can be treated as sonic nozzles by utilizing the concept that air "turning the corner" of the orifice plate, in effect, makes its own nozzle. It is believed that this interpretation of experimental observations is in full agreement with established principles of aero- and thermodynamics. *ASME paper no. 54-A-112.*

Effect of mechanical vibration on the water flow through a ¼-inch sharp-edged concentric ASME orifice in a 1-inch pipe. *By C B Haughton, Jr, Avco Manufacturing Corp, and R E Gorton, United Aircraft Corp.*

In the fall of 1952, during the development of a new type flowmeter containing both variable-area and constant-area orifices, the Fischer and Porter Company discovered that mechanical vibration was seriously affecting performance of the constant-area orifice. Results of special vibration

Directions for ordering papers on page 212

Users of Ferri-Floc enjoy these advantages—whatever your specific water treatment problem may be, you can depend on Ferri-Floc to do the job adequately, efficiently and economically—A partially hydrated ferric sulfate, Ferri-Floc is a free flowing granular salt which can be fed, with a few modifications, through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy and safe handling as well as storage in closed hoppers over long periods of time.

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Efficient coagulation of surface or well waters. Aids taste and odor control. Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial waters.

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Efficient coagulation over wide range of pH values encountered in sewage treatment. Especially adapted for conditioning of sludge prior to vacuum or drying on sand beds.

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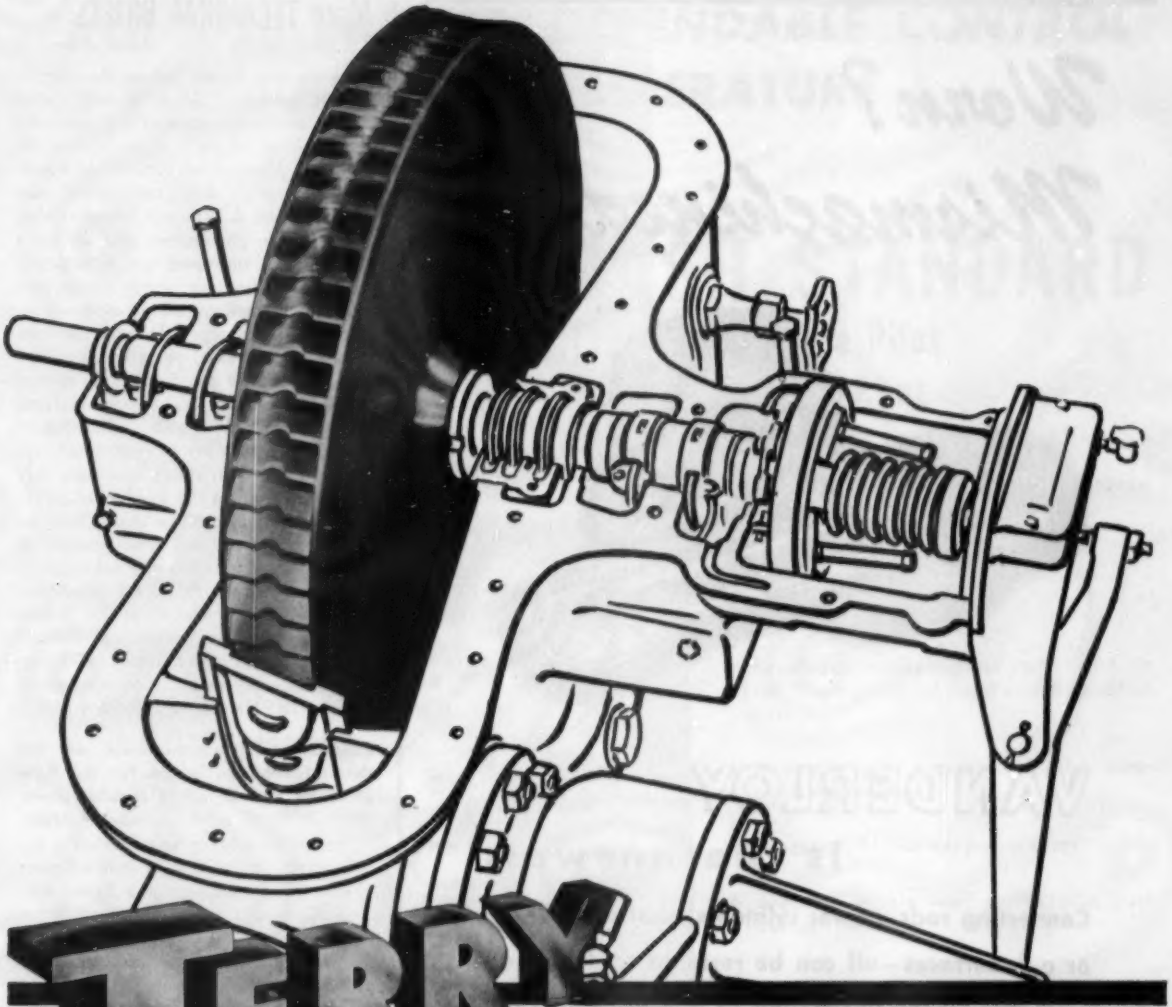

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The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

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The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
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TT-1198

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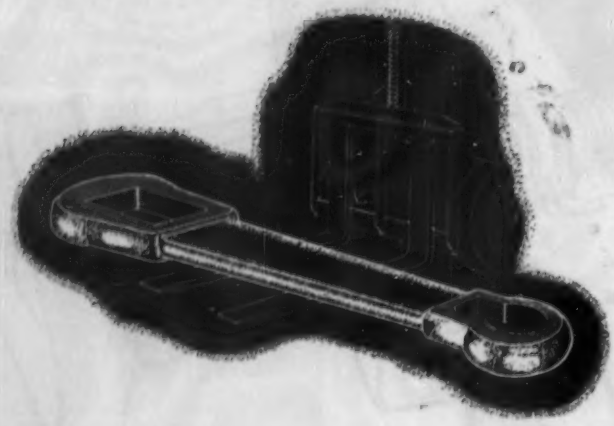

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More TECHNICAL BRIEFS

Begins on page 150

tests on this orifice led to the investigation presented here. It was found that a severe vibration of 8 g produced a flow error of 55% at an orifice differential pressure of 0.95 in. of water.

Shortly after these tests were completed, Pratt & Whitney became interested in the phenomena and set up a considerably improved test in which it was able to produce nearly pure transverse and axial vibrations of the flowing orifice and pipe. These tests demonstrated that axial vibrations produce far greater flow errors than transverse vibrations, and typical maximum error of 83% lower flow with a vibration of 5 g at 150 cycles per sec was measured.

The Pratt & Whitney tests not only appear to confirm the Fischer and Porter tests but also show that effects of g and frequency are considerable. A physical interpretation of what happens at the orifices is offered for consideration, and recommendations for future investigation are presented. Results reported in this paper should be of particular interest to users of very small orifices. *ASME paper No. 54-A-113.*

Experimental determination of the thermal entrance length for the flow of water and of oil in circular pipes. *By J P Hartnett, University of Minn.*

Thermal entrance-length results are presented for the flow of two different fluids, water and oil, in a ¾-in. 4-ft-long tube with a constant heat input per unit length. A hydrodynamic calming section of 97 tube diameters preceded the test section.

Pressure-drop measurements in the water tests indicate that the condition of fully established flow at the test-section entrance was closely approximated, if not actually attained. Confidence in the entry-length heat-transfer results is indicated by the agreement of asymptotic heat-transfer performance of both test fluids with generally accepted correlation equations.

Resulting thermal entrance lengths were from 10 to 15 tube diameters over the Reynolds modulus range of 10^4 to 10^5 and agreed favorably with the analytical results of Deissler and Latzko.

When compared at the same Reynolds modulus, water and oil entrance lengths were in excellent agreement over the range of Reynolds number common to both fluids (17,000 to 48,000), thereby indicating a negligible influence of the Prandtl modulus on the thermal entrance length for Prandtl numbers above unity. In the transition region, experimental entry-length val-

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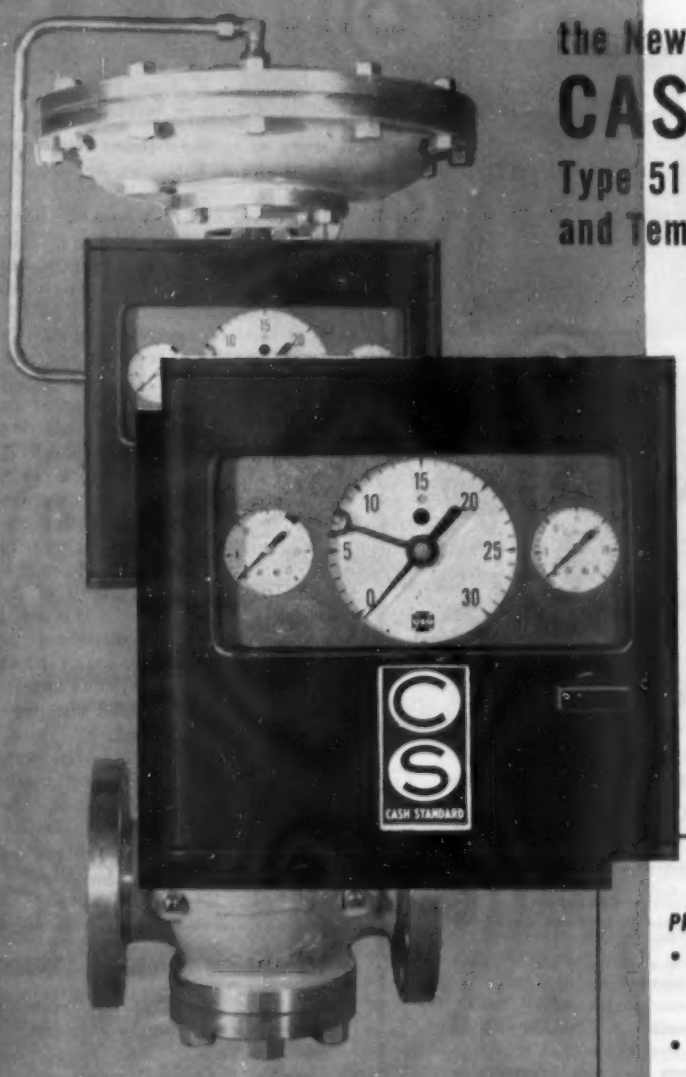

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- Process pressure or temperature gauge incorporated in the pilot
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- Pressure-sensing elements available in phospor bronze, beryllium copper or stainless steel

  Pressure ranges: 0-15 to 0-10,000 psi also 0-30" H_2O and 0-30" Hg vacuum
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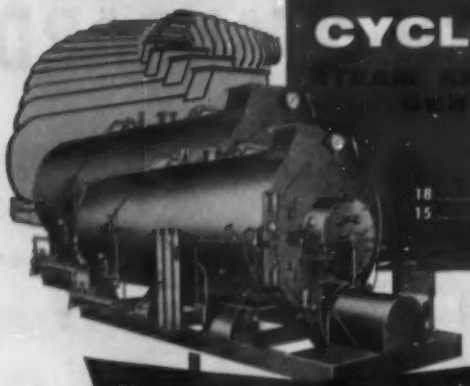

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More TECHNICAL BRIEFS

Begins on page 150

ues are reported for the flow of oil. As the Reynolds number was increased from 2000 to 10,000, thermal entrance length steadily decreased from a large value representative of laminar flow down to a value of approximately 10 diameters. *ASME paper no. 54-A-184.*

Fuels and firing

A study of spreader-stoker reinjection systems. *By W C Holton, Battelle Memorial Institute.*

Reinjection of flyash from spreader-stoker-fired boiler furnaces was initially a means of disposal of this material, but has also come to be regarded as a device for increasing boiler efficiency. Results of tests on four units previously described in the literature are reviewed and compared.

Two types of material balances on reinjection systems are described and illustrated to show that as much as 61% of noncombustible material in reinjected flyash may remain on the grate. In addition, calculations by both a material balance on combustible matter in reinjected flyash and by a total combustible balance, indicate that all of the combustible in the material reinjected can be burned. These calculations are roughly confirmed by increased rates of collection of great refuse found in tests with reinjection as compared with those of tests without reinjection.

It is concluded that, although present systems of reinjection are partly effective in burning or depositing reinjected material on the grate, further improvements could be made to increase efficiency of reinjection. *ASME paper no. 54-A-117.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Power Conference, 17th annual meeting. Identified by initials APC. See page 152 for directions for ordering the entire proceedings.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

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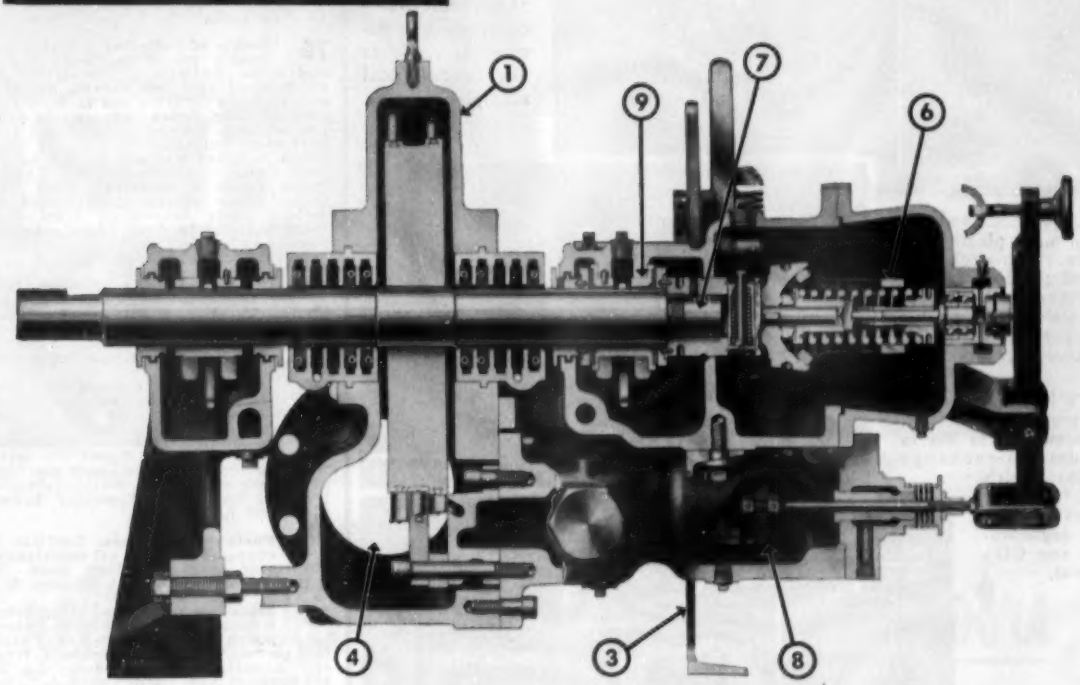

1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is removable for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
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Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
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Weight: 1,200 LB

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

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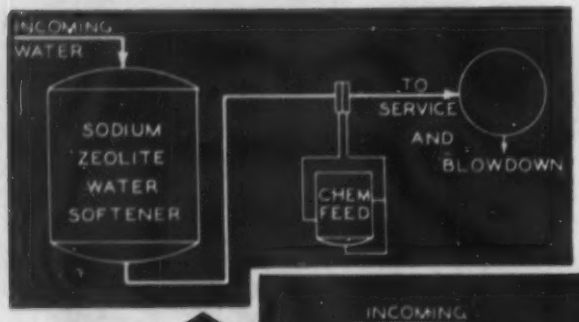
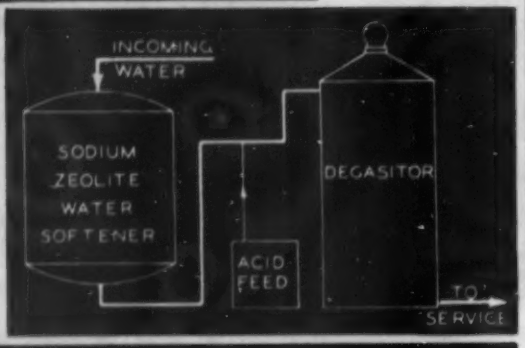
DLSDB

Elgin *CAN* solve your water conditioning problem!

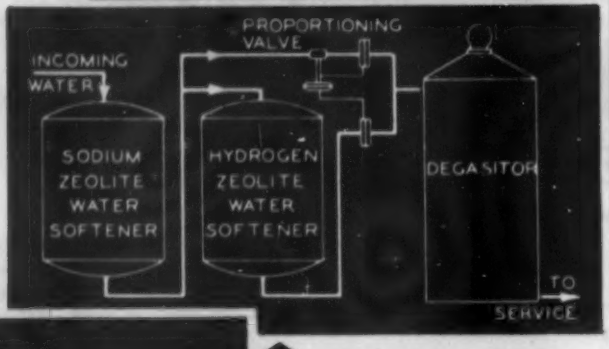
During the years since 1908, it's probable that Elgin engineers have faced — and solved — nearly *every* industrial water conditioning problem. Whether simple or complex, there's an Elgin water conditioning system designed to meet your water treatment requirements — efficiently and economically. Here are four typical examples:

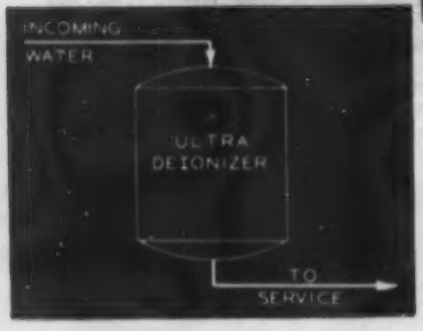


1 In many plants, ordinary ion-exchange softening, plus chemical treatment will deliver soft, scale-free water that will prevent corrosion and corrosion products.



2 Where softened water is too alkaline, the answer often lies in sodium ion-exchange softening with acid feed for neutralization, plus degasification for CO_2 removal.





3 For effective reduction of total dissolved solids, blended sodium and hydrogen ion-exchanger softening, plus degasification, will produce soft, scale-free, low-alkalinity water with CO_2 removed.

4 The Elgin Ultra-DeIonizer produces water of highest known chemical purity. This single-tank mixed-bed unit removes CO_2, silica, and all ionizable solids . . . in limited space and at very low cost.

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More FREE BULLETINS

Begins on page 163

15 **Power cables** for flexible bus-drop power distribution are presented in illustrated 4-p bulletin DM 5541. Anaconda Wire & Cable Co, 25 Broadway, New York 4, New York.

MAINTENANCE MATERIALS

★ **"How zinc controls corrosion"** is title of 32-p illustrated bulletin. Drawings, charts, photos, brief comments present corrosion-control characteristics of zinc coatings, pigments and anodes. ★Request direct from American Zinc Institute, 60 E 42nd St, New York 17, New York.

16 **Series of bulletins** describe company's line of packings, gaskets and seals. Bulletin CP551 covers new mechanical seal for pumps, agitators, etc. Bulletin CP552 gives info on *Teflon* ring packing, *Teflon* impregnated asbestos packing, V-type packing and *Teflon* seal cage. Bulletin CP553 covers line of *Teflon* jacketed gaskets, solid-ring gaskets, *Teflon* expansion joints and special *Teflon* gaskets. Bulletin CP554 illustrates many special molded and machined parts fabricated from *Teflon* Each bulletin is 4-pp. Specify bulletin desired. Chemical & Power Products, Inc, 11 Broadway, New York 4, N. Y.

17 **Blast-cleaning equipment.** Illustrated 8-p bulletin 1403 contains photos, detailed drawings, dimensions, sizes and features on *Hydro-Finish* liquid blast-cleaning equipment. Pangborn Corp, P.O. Box 380, Hagerstown, Md.

18 **Maintenance equipment.** Illustrated 64-p catalog list and describes full line of equipment for commutator, motor and generator maintenance and electrical and mechanical maintenance. Also included are metal-working tools, flexible-shaft machines, and safety equipment. Martindale Electric Co, Box 617, Edgewater Branch, Cleveland 7, Ohio.

19 **Portable oil filters.** Bulletin 316 contains data on oil maintenance ability of units and lists uses. The Hilliard Corp, W 4th St, Elmira, N. Y.

20 **Stainless fasteners.** Comprehensive 8-p bulletin P113A includes information on style and sizes of stainless screws, bolts, nuts, washers, rivets, etc. Allmetal Screw Products Co, Inc, 821 Stewart Ave, Garden City, L. I., N.Y.

HEAT EXCHANGERS, CONDENSERS

21 **Stainless steel tubing** for heat exchangers and condensers. Constructed to conform to ASTM specs A-249 and A-269. Illustrated 11-p bulletin H[illegible]-1. Republic Steel Corp, Steel & Tube[illegible] div, 224 E 131st St, Cleveland 8, Ohio.

22 **Heat-transfer equipment.** Illustrated 4-p bulletin HT-1 covers oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes and coils. Schutte and Koerting Co, Dept HT-B, Cornwells Heights, Bucks County, Pennsylvania.

MATERIALS HANDLING

23 **Steel-belt conveyors** is title of 48-p hard-cover book that describes basic features of the conveyor and steel belt. Gives details on characteristics, capacities, adaptations and design. Sandvik Steel Belt Conveyors, division of Sandvik Steel, Inc, 1702 Nevins Road, Fair Lawn, New Jersey.

24 **Ball-bearing trolleys** for overhead conveyors are detailed in 20-p illustrated bulletin 2536. Includes dimension and application data, description of commonly used attachments. Link-Belt Co, Dept PR, 307 N Michigan Ave, Chicago 1, Illinois.

25 **Sling chains** are subject of 16-p bulletin S-555. Contains data on single, double, triple and quadruple types. Includes full specs and working load limits. Campbell Chain Co, York, Pennsylvania.

26 **Electric vibrators,** vibrating tables and pneumatic vibrators

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Metermax Electric Drive Units operate in outdoor locations in spite of snow, sleet, driving rain, and summer sun. They position fan louvers, vanes, dampers, mill feeders, or any other controlled element. And they never quit as long as you give them power.

There's no need for expensive air dryers, jackets, or weather shelters; the units drive in any kind of weather—BARE—and give you continuous, accurate positioning.

At all times, electric drive units provide the instant response necessary for closely coordinated action in large central stations where controlled elements are widely separated.

As for dependability—these drive units operate for long periods with only routine lubrication. Many have been in continuous service—indoors and outdoors—for more than 15 years.

These specific features may interest you:

Self-locking double worm-and-gear drive. *There's no chance of trouble from backdriving. And no locking devices are needed.*

Self-releasing effect of worm-and-gear *permits resumption of remote manual control immediately on restoration of power . . . you don't have to unlock or reset the individual units.*

Simple remote control. *You transfer quickly from automatic to remote manual control by simply turning the control station handle; there's no reset fuss to bother with.*

Compact, functional control station arrangement. *Because the electric control stations require no piping, a close, functional grouping with other motor controls is possible without losing back-of-panel accessibility.*

True position indication. *You always know precisely the position of your controlled elements; electric indicators respond only to actual movement, independent of friction or sticky dampers.*

Low maintenance. *These units have no packing glands, stuffing boxes, or pilot valves. Your maintenance chores are minimized.*

Standard sizes. *Whether for 25 or for 2500 pound-feet, all torque requirements are fully met by these standard drive units.*

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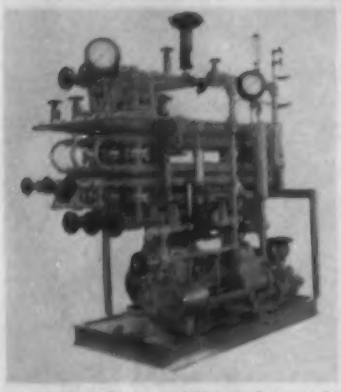

A composite Pump and Heater Set, consisting of one Worthington Steam-Driven Duplex Pump and one Electric-Driven Rotary Pump, with Griscom-Russell Twin G-Fin Heaters mounted above the pumps. Complete with pressure and temperature controls. Fabricated to Consulting Engineer's Specifications. Capacity: 10 GPM of bunker C fuel oil against 175 PSI. Steam pressure 250 PSI.

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Begins on page 163

are described in 8-page illustrated bulletin 11. The Cleveland Vibrator Co, 2828 Clinton Ave, Cleveland 13, Ohio.

MECHANICAL TRANSMISSION

27 **Dry-fluid drive,** *Fluidyne,* is described in 12-p bulletin A-640. Contains photos, cross-section drawings, selection charts, specs. Dodge Manufacturing Corp, Mishawaka, Ind.

28 **Fluid drives** for general-purpose industrial applications. Illustrated catalog and selection guide 9419-9519 itemize and discuss such factors as speed control, power savings, torque limitation, acceleration control. American Blower Corp, Detroit 32, Michigan.

29 **Gears.** Illustrations, diagrams, definitions, tables, charts and explanations regarding all types of gears are included in 76-p catalog G-655. Simplified method of calculating hp ratings of all gearing is shown. Philadelphia Gear Works, Erie Ave & G St, Philadelphia, Pennsylvania.

30 **Adjustable speed drives.** Packaged units provide flexibility of dc motor performance from an ac power supply. Available in ratings to 300 hp; speed ranges to 16:1 and above. Illustrated 4-p bulletin PB4700-1. Elliott Co, Crocker-Wheeler div, Jeannette, Pa.

METERS AND INSTRUMENTS

31 **Filter plant gages** for measurement of effluent flow, loss of head, wash water, water elevation and percent of filter bed expansion. Illustrated 20-p bulletin 1002 describes various types of meters and includes data on operation, construction, sizes and capacities. Simplex Valve & Meter Co, 7 E Orange St, Lancaster, Pa.

32 **Color in instrumentation** is subject of single-page bulletin G71-2. Gives results of study in true color reproduction. Bailey Meter Co, 1050 Ivanhoe Rd, Cleveland 10, Ohio.

33 **Automatic pyrometers.** Illustrated 4-p bulletin G-8 lists standard ranges and specs of units for control of temperature in furnaces and oven. Assembly Products Inc, Chesterland, Ohio

34 **Temperature instruments.** Complete line of thermal systems for indicating, recording, controlling, transmitting, compensating and programming temperatures from — 400 to + 1000 F are illustrated and described in 24-p catalog 12-A-10. Fischer & Porter Co, Hatboro 35, Pennsylvania.

★ **Program control** of process variables is title of 24-p bulletin 1130. Describes methods and advantages of employing automatic, time-conditions control. Selection chart aids in choosing the right instruments. ★ Request direct on company letterhead from Minneapolis-Honeywell Regulator Co, Industrial div, Wayne & Windrim Aves, Philadelphia 44, Pennsylvania.

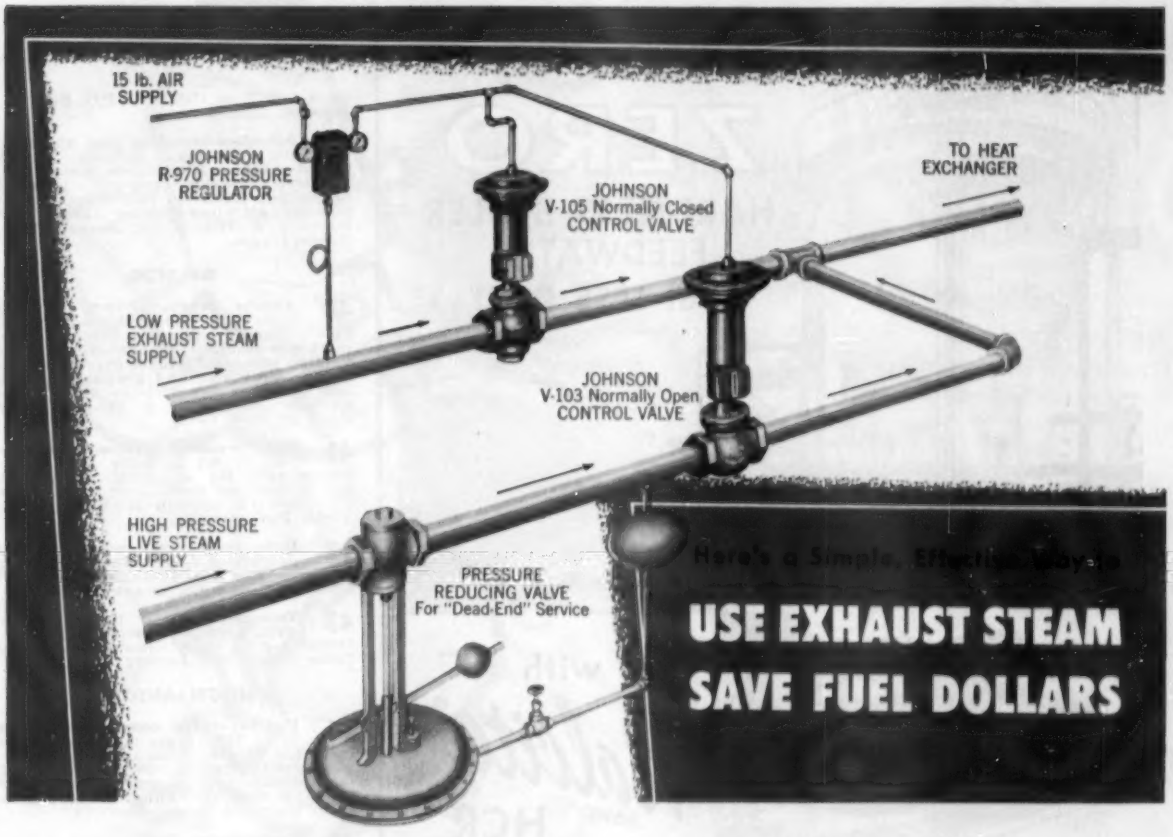
PIPING, VALVES, FITTINGS

35 **Air-release valves** for water, sewage and industrial use. Illustrated 8-p bulletin includes data on installation methods, operation, construction, uses, weights and dimensions. Simplex Valve & Meter Co, 7 E Orange St, Lancaster, Pennsylvania.

36 **High-pressure valves,** adaptors, reactors, autoclaves, thermocouplings, gages, fittings and tubing are outlined in 24-p bulletin 2055. High Pressure Equipment Co, Inc, Erie, Pa.

37 **Lubricated plug valves.** Illustrated 28-p bulletin 39-5 shows straightway, 3-way, 4-way and multiple-port units for 250 lb oil-water-gas and 150 lb steam working pressure. Homestead Valve Manufacturing Co, Coraopolis, Pennsylvania.

38 **Automatic valves,** regulators, controllers, hydraulic valves, refrigeration back-pressure valves and complete systems for process and combustion control are shown in 4-p bulle-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TO HEAT EXCHANGER
LOW PRESSURE EXHAUST STEAM SUPPLY
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PRESSURE REDUCING VALVE For "Dead-End" Service
Here's a Simple, Effective Way to
USE EXHAUST STEAM
SAVE FUEL DOLLARS

Change Automatically to Live Steam ONLY When Necessary!

Why use live steam all the time and run up unnecessary costs when, part of the time, economical *exhaust steam* often can do the job just as well? By utilizing exhaust steam whenever possible, you can easily realize substantial fuel savings.

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Automatically, without attention of any sort, exhaust steam is used whenever it is available. Live steam is consumed only when it is actually needed. There is no chance for the lack of proper steam pressure to be overlooked.

The nationwide Johnson organization offers you over 70 years' experience in solving every conceivable type of temperature control problem. Whether your special problem involves the application of a single controller or an intricate control system, a Johnson engineer will gladly recommend the best solution without obligation.

Complete engineering, sales, installation and service facilities are readily available from more than 90 direct branch offices.

For more information about the equipment illustrated, mail the coupon today.

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TEMPERATURE AIR CONDITIONING

PLANNING • MANUFACTURING • INSTALLING • SINCE 1885

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Please send me your apparatus bulletins describing the following equipment:

- ☐ R-970 Pressure Regulator
- ☐ V-105 Normally Closed Steam Control Valve
- ☐ V-103 Normally Open Steam Control Valve
- ☐ New Condensed Catalog of All Johnson Control Apparatus
- ☐ Have a Johnson engineer call me.

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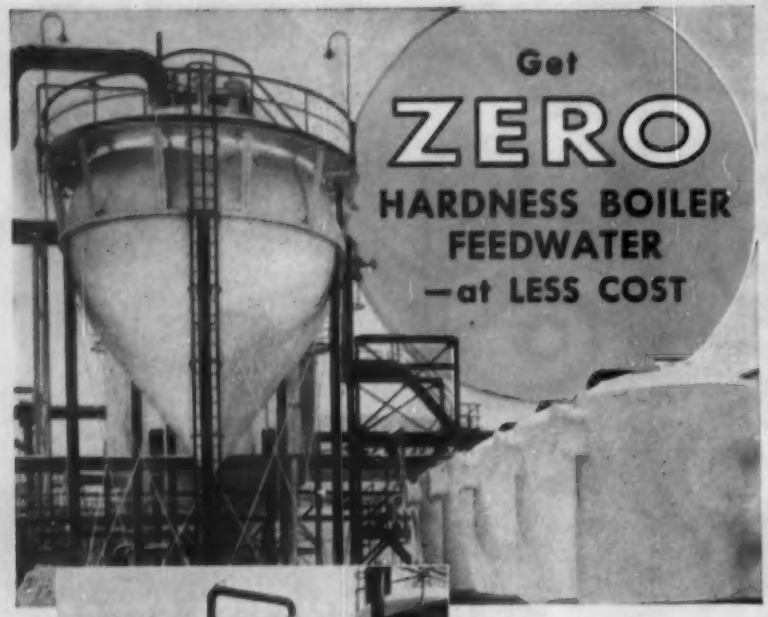
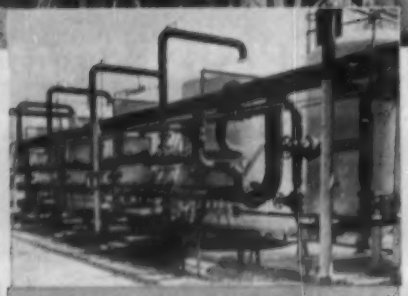
ADDRESS_____

CITY_____ ZONE_____ STATE_____





Top photo shows new outdoor hot lime-zeolite softener installation in a Southern refinery. Five Nalcite HCR ion exchange units (lower photo) have output of 470,000 gallons of zero hardness water between regenerations.

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Nalcite® (DOWEX*) HCR
HOT LIME
ZEOLITE
TREATMENT

● Start with the simplicity of operation . . . add the low operating costs of hot lime-zeolite softening . . . all made possible by the outstanding high-temperature performance of Nalcite HCR in the zeolite softeners. Results: Zero hardness water, from virtually any raw water source, with a minimum of testing and control required. See your water treating equipment manufacturer for details on new or conversion hot lime-zeolite treatment for your plant . . . and for top softener efficiency, specify Nalcite HCR.

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6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

More FREE BULLETINS

Begins on page 163

tin S-730. A W Cash Co, P.O. Box 551, Decatur, Illinois.

39 **Seamless-stainless pipe** and tubing. Six-page bulletin TB-355 contains tables of analyses, mechanical properties, creep strength, physical properties, oxidation resistance of nine popular stainless tubing steels. The Babcock & Wilcox Co, Beaver Falls, Pennsylvania.

WELDING

40 **Article reprint** "Spot welding from one side—with a portable gun." This 12-p reprint describes the inert-gas-shielded tungsten-arc spot welding process. Includes over 30 tables, photos, drawings and graphs. Air Reduction Sales Co, division of Air Reduction Co, Inc, 60 E 42nd St, New York 17, New York.

41 **Stainless-steel electrodes** is subject of 4-p bulletin AR-10. Includes selection and application data for 22 popular electrodes. Alloy Rods Co, Dept 34, Lincoln Highway West, York, Pennsylvania.

42 **Data card** gives stress-rupture properties of stainless-steel weld deposits. Bulletin TDC-178. The Babcock & Wilcox Co, Beaver Falls, Pa.

43 **Tungsten-carbide** hardsurfacing weld rods are described in illustrated 4-p bulletin. Coast Metals, Inc, Little Ferry, New Jersey.

MISCELLANEOUS

44 **Feather-valve compressors** from 75 to 350 hp are described in illustrated 32-p bulletin L-676-B1A. Advantages on installation, operation and maintenance costs are outlined for type *YC* and *DYC* units. Worthington Corp, Harrison, New Jersey.

45 **Precipitator.** Applications, principles of operation, design features, advantages, recommendations, flow diagrams and specs are presented in illustrated 20-p bulletin 2204C. The Permutit Co, 330 W 42nd St, New York 36, New York.

46 **Progress report** outlines 3-yrs experience in supercharged internal-conductor cooling of steam turbine-generators. Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wisconsin.

47 **Insulation.** Four-page chart-type bulletin presents recommended insulations for varying temperature problems. Mundet Cork Corp, Insulation division, 7101 Tonnelle Ave, North Bergen, New Jersey.

48 **Steel grating** and stair treads are subject of heavily-illustrated 24-p bulletin. Contains data on welded, serrated and riveted grating, fastening devices for anchoring grating to supports, stair treads and decking. Standard Steel Spring Div, Rockwell Spring and Axle Co, 4000 E 7th Ave, Gary, Ind.

49 **Storage equipment** — including racks, bins, shelves and pallet frames—is subject of 16-p illustrated bulletin 702. The Frick-Gallagher Manufacturing Co, 110 S Michigan Ave, Wellston, Ohio.

50 **Nuclear reactor systems,** remote handling equipment, electromagnetic pump and coolant system components are pictured and described in 4-p bulletin GEA-6014. General Electric Co, Electric Apparatus Sales Div, Schenectady 5, New York.

The John H Kerr Dam on the Roanoke River in Virginia is now complete with six 35,555-kva waterwheel generators and one of 13,333 kva. The machines were supplied by the T & G div, E Pittsburgh Works of Westinghouse Electric Corp. The generators run at 85.7 and 138.5 rpm respectively.

Has that man gotten lazy? All he does is sit and watch the gauges.

The more he sits on his chair, the better I like it. It means the steam pressure is where it should be and everything is fine and dandy.

He used to be jumping around like a monkey on a hot stove.

That was before we got wise and changed our coal.

What kind of coal are we using now?

It's a high quality, low ash coal produced on the Chesapeake and Ohio. The C&O coal man recommended the exact grade best suited to our type of furnace. It burns hot and clean, with practically no smoke or clinkers and very few ashes. I've learned there's a lot more to buying coal than merely the price per million BTU's. It takes a competent combustion engineer to weigh all the factors and pick the coal that will give the most economical operation under a given set of conditions. Those C&O people really know their coals and I'm listening to their advice from now on.

P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

Self-Contained Steam Production to Fit Your Need

19 SIZES

20 to 434 HP, S.B.I. Rating Delivering 48 to 487 HP, Maximum Continuous Output

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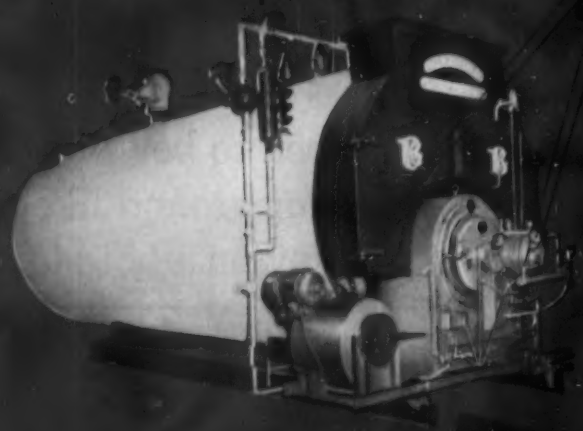
UNITS



READY TO OPERATE AS SOON AS CONNECTED
Combines the boiler that closely fits your requirements with whatever top quality burner best suits your specific situation . . . Mounted on a steel base . . . Requires no special foundation, no high stack, no induced draft fan.

80% EFFICIENCY
Tubes correctly proportioned for efficient heat transfer promote 80% or greater efficiency.

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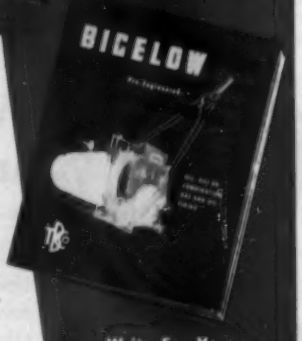
8.2 square feet of heating surface per boiler horsepower, (STEEL BOILER INSTITUTE STANDARD) provides maximum continuous output reserve capacity 50% greater than nominal S.B.I. rating.

COMPLETELY AUTOMATIC — OIL, GAS OR COMBINATION GAS & OIL FIRING



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Catalogs also available on Bigelow Water Tube Boilers of various types.

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BI-17

REPORTS from the FIELD

Continued from page 148

of carbon dioxide and water vapor. The process is accompanied by a tremendous release of heat energy. To Sun, this heat release—a total of 110,000,000 Btu per hr at the two plants—represents a potential fuel saving of $400,000 per yr, based on the cost of 150,000 barrels of oil which would be needed to supply steam to the cat crackers. Since the waste-heat boilers cost Sun $800,000 they should pay for themselves in fuel savings within two years. After that, they are expected to produce free steam and at the same time to provide continuous insurance against air pollution.

Times Sq-Grand Central shuttle belt shelved

► NEW YORK CITY Controller Lawrence E Gerosa has turned thumbs down on the proposed Grand Central-Times Square conveyor belt to replace the present shuttle trains (POWER, May 1955, p 126).

He considers the project "too experimental and hazardous." The matter has been scheduled for discussion and possible action late in August. Gerosa hopes to convince members of the Board of Estimate and the new Transit Authority to drop the conveyor project entirely.

His reports declare that the project is too risky, that there are no provisions made for possible breakdown of the small cars between stations, that adequate provision had not been made for ventilation and that all in all it was "a doubtful proposition."

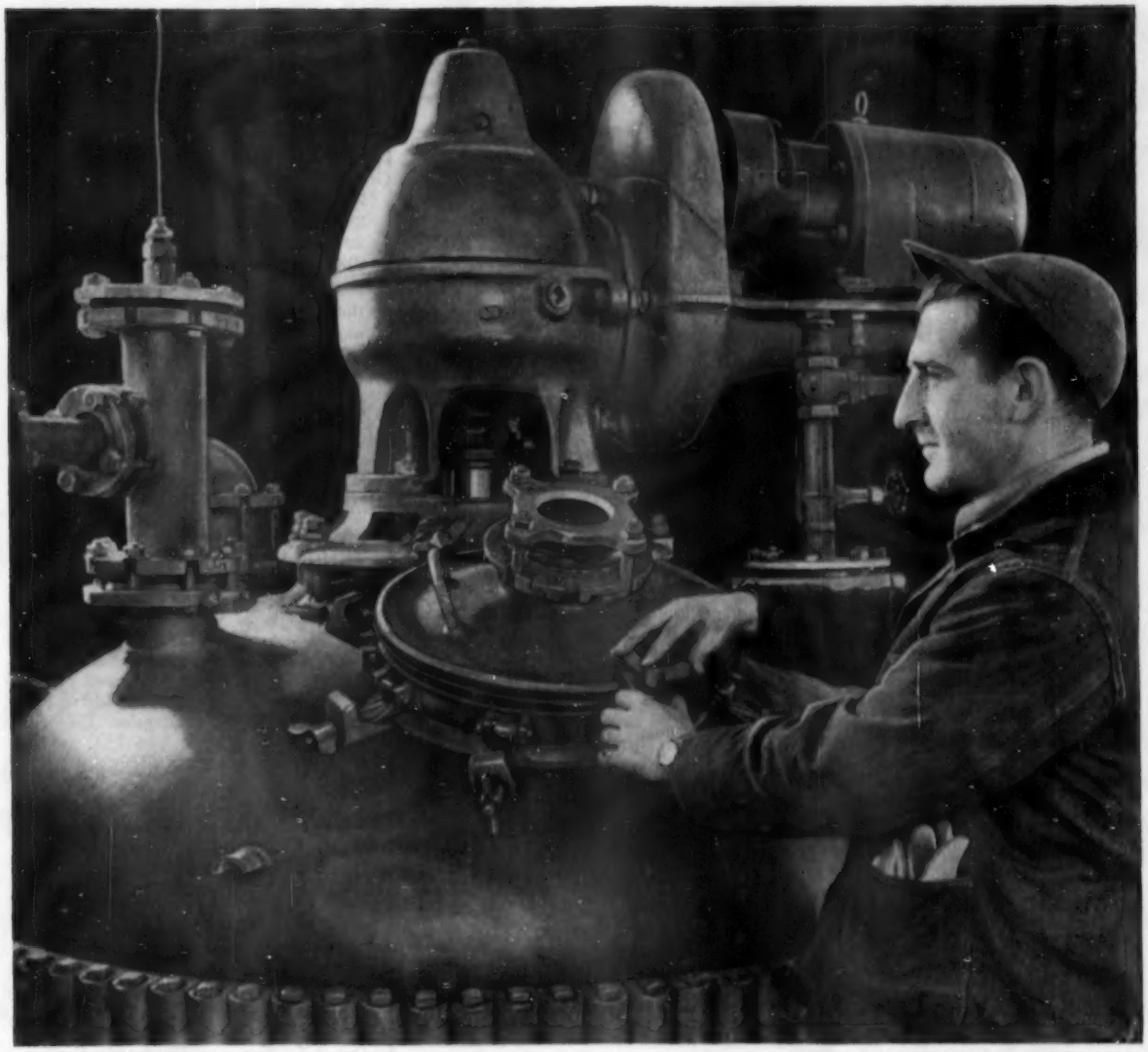
Diesel plant will ease Costa Rica's power shortage

► COSTA RICA IS PREPARING now to ease a power shortage expected during next year's dry season with plans for one of the largest diesel-electric power plants in Latin America, said R D McManigal, vice-president of Westinghouse Electric International Co.

Nordberg Manufacturing Co, prime contractor, is building four diesel engines for a 16,500-kva generating station at San Jose. Westinghouse is supplying generators, transformers, controls and other electric apparatus.

The project, scheduled for completion late in 1955, is being partially financed by a $1,023,000 Export-Import Bank credit granted last March.

"More than nine-tenths of Costa Rica's power is hydroelectric," McManigal said. "The new unit will assure a stable source of power when there is too little water to drive the turbines at full capacity. The country's dry season begins in January and lasts up to five



Reaction kettle for making ion exchange resins at The Permutit Co., Birmingham, N. J.

Why we make our own ion exchange resins:

First—in order to offer our customers the best resins.

But the main reason we make our own resins is that we can "tailor" their molecular design, chemical and physical characteristics to best meet process and equipment requirements. It gives us greater control of capacity, efficiency, stability and mesh size.

It also supplements our production of other types of zeolites with the result that Permutit (and only Permutit) makes all widely used types of ion exchangers . . . from rugged natural greensands for simple, low-cost water softening to specialized resins for purifying chemicals.

And it enables us to offer an integrated Water Conditioning Service including water analysis, engineering, equipment, controls and the ion exchange material itself . . . from one source . . . under one responsibility. That's how "weak links" can be avoided. That's why Permutit equipment gives long years of trouble-free service.

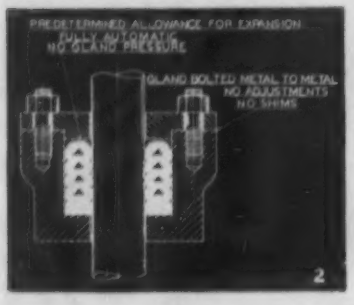
For further information, write The Permutit Company, Dept. P-9, 330 West 42nd St., New York 36, N. Y.

PERMUTIT®
WATER CONDITIONING
Equipment • Resins • Experience

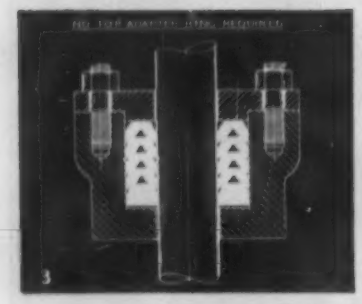
NEW Positive self-sealing PACKING without pressure limitations

CHESTERTON PARACHUTE

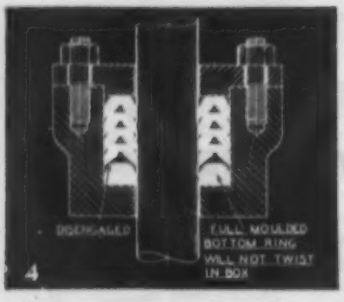
STYLE 600



Chesterton Parachute is a fully-automatic, self-lubricating packing which requires absolutely no attention or adjustments after it is installed. It has proven superior for hydraulic rams and rods for all services; oil, steam, water. Because of its automatic features, Parachute seals on the pressure stroke only, thus guaranteeing twice the service over other V type molded packings which require constant gland pressure and adjustment. Due to its unique design, Parachute has individual lubrication retention channels between each sealing ring.



Compare Parachute's full-bodied construction with thin conventional V style rings. Note full-molded bottom ring with pilot sides which cannot twist in the box. Note each ring seals as an individual unit and that no special top adapters are necessary as each Parachute ring has molded flat top surface. Due to its rigid construction and proven service, Parachute does not require metal reinforcing or separator rings even on extreme pressures. Please write us for a four page descriptive bulletin.



SERVICE	Parachute Style
For Water & Hydraulic	600W
For Air & Steam	600S
For Cold Oil & Solvents	600C.O
For Hot Oil & Solvents	600H.O

PACKING Chesterton SERVICE

A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

REPORTS from the FIELD

Begins on page 148

months, cutting power supply by as much as fifty percent."

One urgent use for the installation will be to supply energy for the pumping of available river water for irrigation. When other generators are eventually added to the power system, the diesel-electric station will be especially useful for "peaking" operations during the heavy load periods of early morning and evening.

The project is part of a program of Instituto Costarricense de Electricidad, a government agency, to develop about 60,000 kw of new facilities.

Calendar of Events

Sept 12-14—American Institute of Electrical Engineers, 2nd electrical conference of the petroleum industry. Shamrock Hotel, Houston, Texas. Details from AIEE, 33 W 39th St, New York 18, N.Y.

Sept 12-16—Instrument Society of America, 10th annual instrument conference and exhibit. Shrine Exposition Hall and Auditorium, Los Angeles. Complete information obtainable from ISA, 3443 S Hill St, Los Angeles 7, California.

Sept 19-21—Edison Electric Institute, 8th annual round table conference. Drake Hotel, Chicago. Details from Industrial Relations Committee, EEI, 420 Lexington Ave, New York 17, New York.

Sept 26-30—Atomic Industrial Forum, 1st trade fair of atomic industry. Sheraton-Park Hotel, Washington, D.C. Complete information obtainable from AIF, 260 Madison Ave, New York 16, New York.

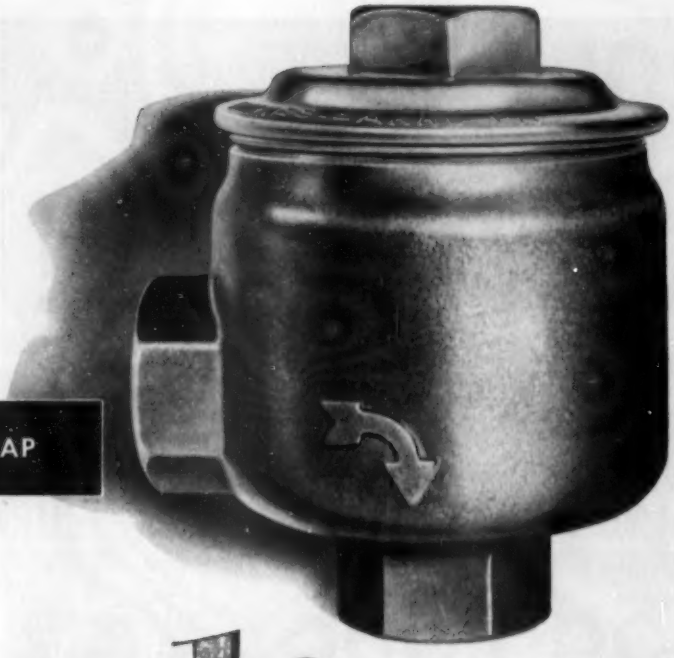
Oct 3-5—National Electronic Conference, 11th annual meeting. Hotel Sherman, Chicago. Details from J Kocik, c/o Illinois Bell Telephone Co, 208 W Washington St, Room 300, Chicago 6, Illinois.

Oct 3-7—American Institute of Electrical Engineers, fall general meeting. Morrison Hotel, Chicago. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Oct 17-19—Engineer's Society of Western Pennsylvania, 16th annual water conference. Hotel William Penn, Pittsburgh. For complete information address the Society Office, Hotel William Penn, Pittsburgh 30, Pennsylvania.

Oct 17-21—National Safety Council, 43rd national safety congress and exposition. Conrad Hilton, Congress, Morrison and LaSalle Hotels, Chicago. Details from R L Forney, NSC, 425 N Michigan Ave, Chicago 11, Illinois.

Oct 24-25—Steel Founders' Society of America, fall meeting. The Greenbrier, White Sulphur Springs, W. Va. Complete



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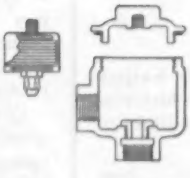
Quality

Just 3 quality parts—thermostatic bellows, body, cap. Simple, positive action. Won't leak!



Nicholson quality . . . that gives you the extra strength, extra capacity, extra *stamina* required for severest steam distribution service. Nicholson quality pays off, when it comes to discharging condensate and air from steam lines . . . most efficiently, dependably, economically.

- **Powerful valve action—big husky bellows.**
- **Positive shut-off—finely ground valve and seat.**
- **High capacity—large diameter orifice.**
- **Rigidly tested—on actual steam lines.**

When less than best won't do, specify Nicholson. Send for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

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Vast power projects throughout the world—more than seventy in all—attest to The Kuljian Corporation's reputation as SPECIALISTS IN THE POWER FIELD. These power plants, with capacities ranging from 2,500 to 240,000 KW, represent a total investment of over half a billion dollars.

No matter what type of power project you are planning . . . be it steam, hydro, or diesel . . . Kuljian's wealth of practical experience, backed by a complete staff of internationally recognized engineers, can serve you quickly, economically, and efficiently to meet your specific requirements.

Next time *you* need outside help, why not contact a Kuljian engineer for preliminary consultation. He will be glad to provide the help you need, anytime . . . anywhere.

ACTUAL ON-THE-JOB REPORTS are continually received at Kuljian headquarters. From these reports, easy to read case histories are developed into articles that are published by editors of leading magazines.

If you are interested in knowing more about us . . . how we work, what we have done for others . . . your request for literature will be most welcome.

The Kuljian *Corporation*

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BRANCH OFFICES THROUGHOUT THE WORLD

REPORTS from the FIELD

Begins on page 148

information obtainable from SFSA, 920 Midland Bldg, Cleveland 15, Ohio.

Nov 1-5—World Symposium on Applied Solar Energy sponsored by Stanford Research Institute, Assn for Applied Solar Energy and the University of Arizona. Westward Ho Hotel, Phoenix. Details from Public Relations Dept, SRI, Stanford, California.

Nov 8-11—Institute of Power Engineers, 1955 Canada's Power Show. Show Mart Bldg, Montreal. Complete information from IPE, 410 Bloor St East, Toronto 5, Ontario.

Nov 14-18—American Society of Mechanical Engineers, Chicago exposition of power and mechanical engineering. Chicage Coliseum. Details from ASME, 29 W 39th St, New York 18, New York.

Underground steam power plant will have 600,000 kw capacity

► STOCKHOLM (McGraw-Hill World News). Blasting has begun on what is claimed to be the world's largest underground steam power plant. Total rock removal will be over 35-million cu ft. Each of the four sections of the plant, consisting of a 150,000-kw turbine generator and boiler, will be housed in a chamber measuring 330x80x100 ft. Roof of the chambers will lie more than 300 ft below the surface.

Located in Stenungsund near Gothenburg, the plant is being built by the State Power Board. The turbine generators are to be the largest ever built in Scandinavia. Total cost of the plant is estimated at $57-million.

Factory to produce parts for atomic power plants

► THE FIRST PRIVATELY-FINANCED factory designed to produce parts for atomic power plants has been opened by Westinghouse Electric Corp. The plant is located in Cheswick, Pa.

First product to be manufactured was a canned motor-pump designed to send radioactive fluids through the hermetically-sealed systems of nuclear power plants. A high-pressure "proving ground" constructed within the factory has facilities for full-scale testing of these pumps and valves used in atomic power systems.

Industrial conferences offered by University of Wisconsin

► A SERIES OF industrial conferences will be offered this fall by the Engineering Institute of the University of Wisconsin. Kickoff conference will be the

Here's where you get the answers to pipe problems

● Look under "The Youngstown Sheet and Tube Company" in one of these alphabetical or classified phone books.

They represent the 28 conveniently located district sales offices Youngstown maintains across the country. Offices staffed by men who are specialists in steel and who know pipe. They understand **your** problems and are qualified to help you get the pipe you need.

If you aren't in touch now with a Youngstown pipe distributor, just call the Youngstown district office nearest you and we will help you solve your pipe problems.

QUALITY YOUNGSTOWN SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices Youngstown, Ohio District Sales Offices in Principal Cities.

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - BLACK PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS

What's your need for heat?

Whatever your heating job may be, you'll find the efficient, economical answer in . . .

CHROMALOX Electric Heaters

. . . for heating platens, dies, molds, metal parts . . . for heating liquids, air, gases . . . for curing, drying, baking . . . for comfort heating in offices and factories . . . for special applications . . . in fact for any application requiring fast, low-cost, controlled heat up to 1100°F.

IMMEDIATE DELIVERY

from the world's largest factory stock of industrial electric heaters . . . over 15,000 types, sizes and ratings.

Let the Chromalox Sales-Engineering staff solve your heating problems . . . electrically.

Write for your copy of Catalog 50

Contains helpful information on design uses, and prices of Chromalox Electric heaters, elements, thermostats, contactors and switches.

To get some interesting facts about additional applications of electric heat, ask for Booklet F1550—"101 Ways to Apply Electric Heat."

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REPORTS from the FIELD

Begins on page 148

Diesel Engine Operators Institute which will stress methods of training operating personnel of diesel engines used in power plants and pumping stations. Latest information about maintenance and operation of oil and dual-fuel units and their auxiliary equipment will be presented during the Institute, to be held Sept 15-16 on the Madison campus.

Other institutes of general interest will include: Technical Expression, Oct 5-7; Industrial Motor Control, Oct 13-14; Industrial Noise Control, Nov 3-4. For complete information write Engineering Institutes, University of Wisconsin Extension Division, Madison 6, Wisconsin.

Safety Center announces fall courses

► THE CENTER FOR Safety Education at New York University will offer eleven accident and fire prevention courses beginning September 26.

Bulletins describing the courses in detail and giving full information about fees and registration may be secured by writing Dr Walter A Cutter, Center for Safety Education, Division of General Education, New York University, New York 3, N. Y.

National Resources Conferences scheduled

► NATIONAL RESOURCES CONFERENCES, conducted by the Industrial College of the Armed Forces will be held in major industrial centers again this year.

These conferences are a condensed version of the resident course at the Industrial College. They outline the world situation and how it affects our national security, and describe in broad terms the national resources that are the basis of our security and our position in world affairs.

The conferences are intended to stimulate thinking about our security problems. Each session lasts two weeks. The daily hours are reasonable so business people can attend and yet take care of urgent business matters. A team of six officers from all the military services delivers 32 lectures. There are also discussion periods, films, and field trips.

Subjects covered include organization for national security, procurement practices and procedures, war finance, manpower, strategic and critical materials, internal security, production, foreign aid and mutual security, economic warfare, requirements for mobilization, fuel and power, emergency management, civil defense, Soviet communism.

In each city, the conferences are jointly sponsored by a civilian organiza-

Stop Corrosion

in boilers, steam and return lines . . .

with this Stickle deaerating feed water heater

SAVES STEAM
Vent Condenser releases only air and contaminated gases to atmosphere
NO CONTAMINATION
Counterflow of steam and water prevents reabsorption of oxygen
SELF-CLEANING
There is no need for removable baffles or trays

Stickle Baffle Spray Type Deaerating Feed Water Heaters stop corrosion by removing destructive oxygen and carbon dioxide from boiler feed water . . . reduce fuel costs and boiler strain. Vertical and horizontal models. Capacity range: 3,000 to 300,000 pounds per hour. The latest development in more than 50 years of building feed water heaters.

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S-217 . . . Baffle Spray Type Deaerating Feed Water Heaters
117 . . . Open Coil Feed Water Heaters

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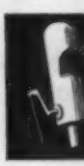


Stickle Equipment
Cuts the cost of steam

Why Arizona Public Service chose Triple-Zone Gilsulate to protect 1200-foot fuel and steam lines

Sought lifetime protection against heat loss and corrosion

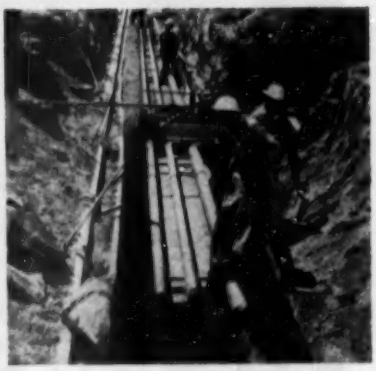
For its new Saguaro steam electric station near Red Rock, Arizona, the Arizona Public Service Company investigated several types of hot underground pipe insulation. The pipe system consists of three seamless carbon steel hot fuel and steam lines, totalling 1,200 feet, with welded joints running side by side between a 55,000-bbl. fuel oil storage tank and two 950,000 pound/hour steam generators.

Arizona Public Service Company found that GILSULATE gave the quickest, simplest and most economical system of insulation for its underground hot fuel and steam lines. Approximately 40 tons of GILSULATE were poured and tamped by 10 laborers in two 8-hour shifts – far less time and less expense than required for the other types of insulation investigated.

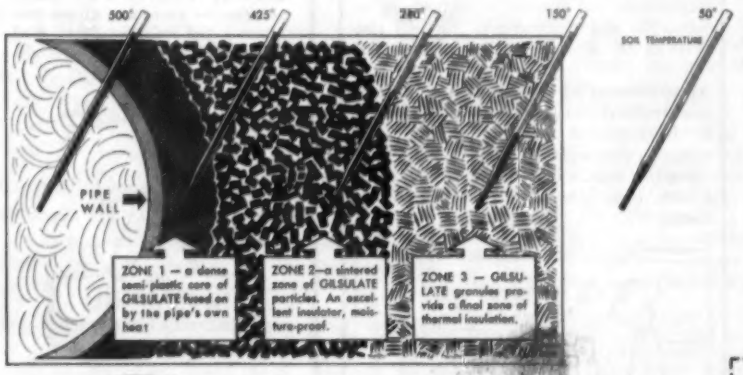
This is the experience of hundreds of other installations – *Triple-Zone GILSULATE shows the lowest cost per installed linear foot of any hot underground pipe insulation!*

Facts about Gilsulate

1. *Easy to use*—just pour, tamp and backfill...pipe heat does the rest.
2. *Forms 3 zones of protection* against heat loss and all commonly encountered hazards to hot buried pipes.
3. *Needs no sleeves* or mechanical sheaths: no mixing or special handling.
4. *Needs only* normal pipe spacing: for multiple pipe or cramped conditions.
5. *3 types* for varying temperature ranges up to 520° F.



Lines include five horizontal expansion U-bends. A 6-in. fuel oil supply line, a 4-in. fuel oil return, and a 4-in. saturated steam line leading to the fuel oil tank heater were placed side by side in a 37-in. wide trench, and covered with GILSULATE. After light tamping of GILSULATE, trench was backfilled—and the work was done.


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 — a dense semi-plastic core of GILSULATE fused on by the pipe's own heat
ZONE 2—a sintered zone of GILSULATE particles. An excellent insulator, moisture-proof.
ZONE 3 — GILSULATE granules provide a final zone of thermal insulation.

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF HOT UNDERGROUND PIPES

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"See What Goes On Inside"

For insertion into pipe

FOR EVERY APPLICATION

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FIG. 29 Cylinder with Impeller

FIG. 17-28 Cylinder

FIG. 215 Flanged

FIG. E-57 Double Window

FIG. 212 Visibility Welding Neck or Screw

FIG. E-811 Flapper

FIG. E-1810 Rotating Wheel Type

All sizes up to 6" Send for Catalog

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REPORTS from the FIELD

Begins on page 148

tion and the local military commands. Interested civilians should apply to the selection committee of the civilian sponsoring agency in their city. This is the local Chamber of Commerce except in Miami, where it is the Dade County Board of County Commissioners.

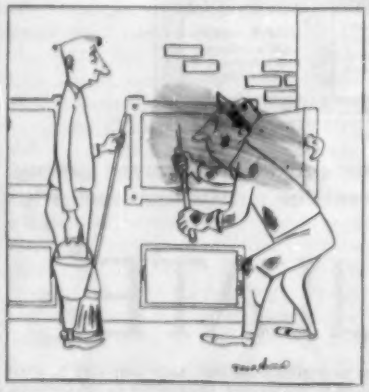
Conferences will be held in these cities: Houston, Tex., Sept 19-30; Detroit, Mich., Sept 26-Oct 7; Santa Barbara, Calif., Oct 17-28; Portland, Oregon, Oct 24-Nov 4; Miami, Fla., Nov 28-Dec 9; Ogden, Utah, Nov 28-Dec 9; Mobile, Ala., Jan 16-27, 1956; Berkeley, Calif., Jan 23-Feb 3; Jackson, Miss., Feb 13-24; Shreveport, La., Feb 13-24; Waco, Tex., Mar 12-23; Savannah, Ga., Mar 12-23; Des Moines, Iowa, Apr 9-20; Chicago, Ill., Apr 16-27; Buffalo, N. Y., May 21-June 1; Richmond, Va., May 14-25.

To speed development of valves and fittings designed for use in nuclear power systems, the Walworth Co is establishing a new research and development division at Boston. Dr F C Monkman Jr has been named to head the new program.

Robert Harens, executive vice-president of Byron Jackson Co, has been appointed to the Membership Advisory Council of the Atomic Industrial Forum.

Editorial offices of American Society for Engineering Education have moved to the University of Illinois, where national headquarters are located. Succeeding Prof Clarence Watson of Northwestern University as editor will be Dr Lisle Rose, prof of general engineering and director of engineering information and publications. He will also serve as ASEE public relations director.

Appointment of E A Schmidt as Midwest regional manager has been announced by I-T-E Circuit Breaker Co. The sales offices in this region include Chicago, Cincinnati, Cleveland, Detroit, Indianapolis, Kansas City, Minneapolis, Omaha and St. Louis.



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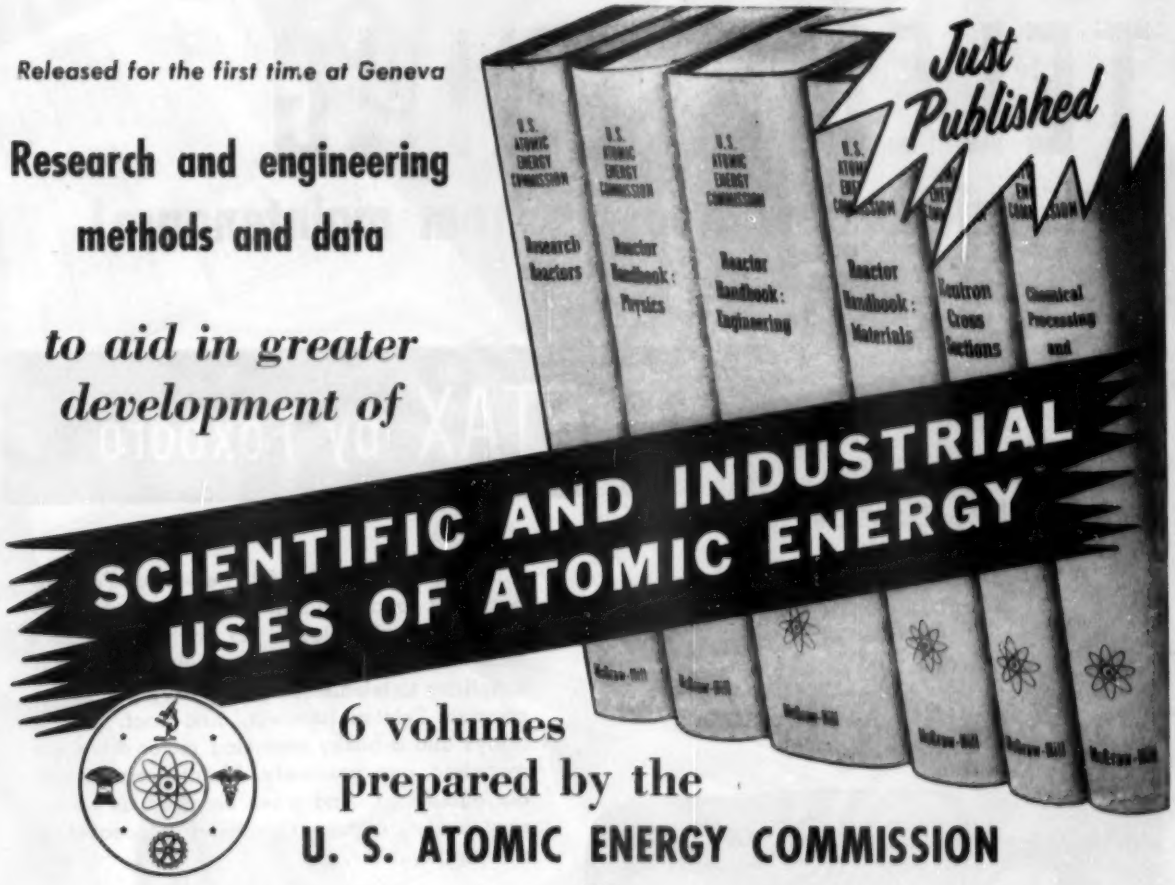

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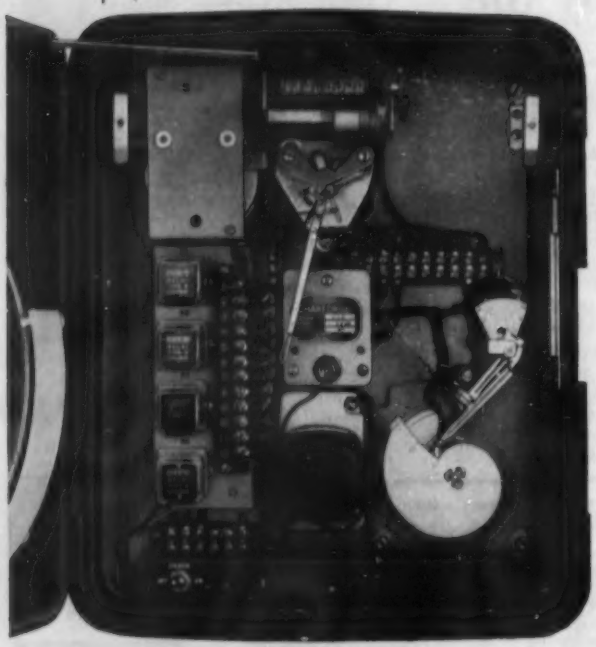

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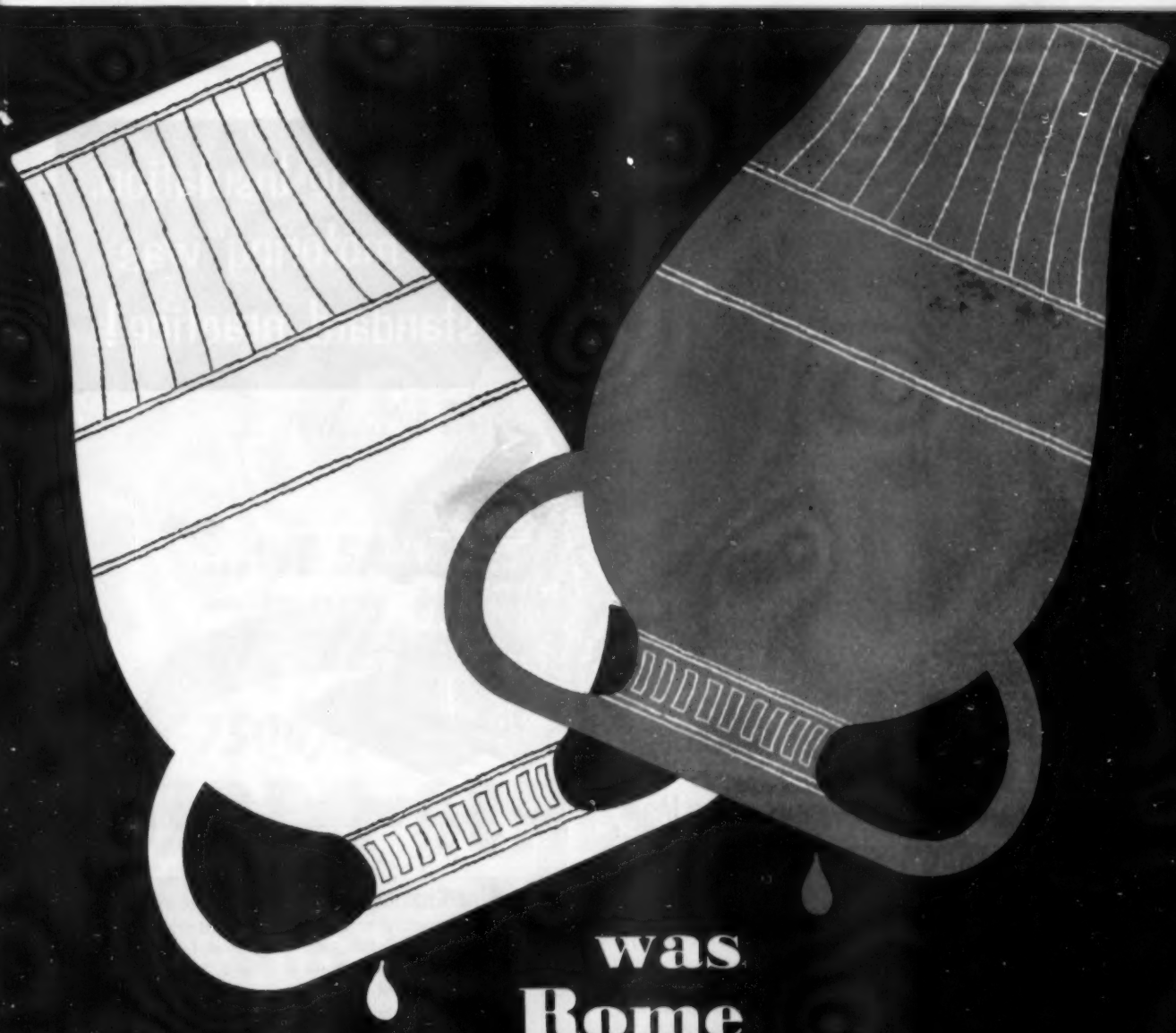

was Rome burned up!

Not the city, mind you, for this was before the days of the Nero caper, but the people — they wanted water. Summers were getting hotter and Romans were getting thirstier. They needed something to drink — with or without calories. Thus began the construction of Rome's famous aqueducts, one of which, scarred but faithful, served the city for almost nine hundred years!

These early aqueduct builders had more to contend with than their thirst. For one thing, they had to carry the ball alone. No skilled specialists or professional consultants stood ready to provide their answers. Today, carrying the ball alone is almost as defunct as the aqueducts themselves. Experienced consulting, design and operating engineers — each contributing his unique skills — cooperate in solving complex water and waste problems that would have amazed the early Romans. Graver believes this interrelation is not only useful but desirable and that all involved can not help but profit by it.

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...but now you can match the load; let silicones carry the overload!

Overload capacity ranges up to 50% for Class H compared with 15% for comparable Class A motors.

that means

- ***more efficient use of motors.*** You can use the service factor built into silicone insulated motors to carry most initial or intermittent overloads or loads that can't be matched in standard frame sizes.
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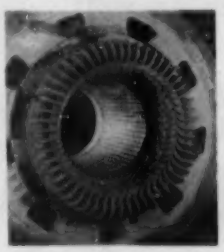
Allis-Chalmers gives you maximum overload capacity and maximum resistance to abrasion, moisture, vibration and to both electrical and mechanical fatigue in "Silco-Flex" insulated motors.

The Allis-Chalmers all silicone rubber insulating system made with Silastic*, is now available in most motors of 500 hp and larger. They offer longer life and more economical operation under severe operating conditions in power plants and mines, and in such continuous process industries as cement, chemical, food, paper and rubber manufacturing.



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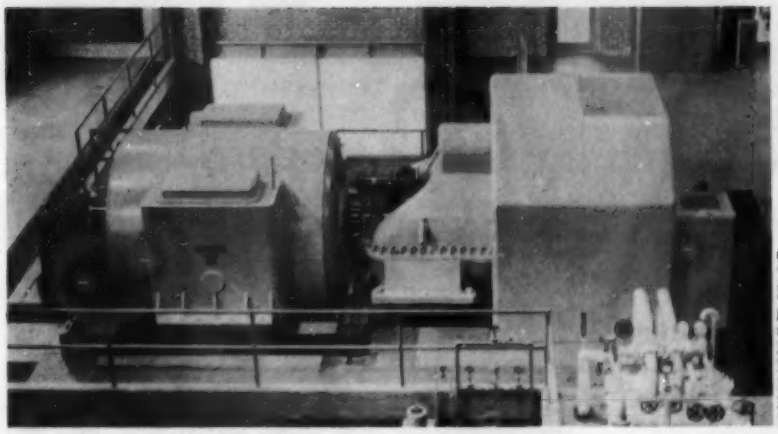

and, we're more than pleased with their operation"

One of the two 7500/9375 kw Brown Boveri steam turbine generator sets installed in the new McWilliams Power Plant of the Alabama Electric Cooperative, Inc. at Gantt, Alabama.

ANOTHER Brown Boveri turbo-generator installation is on its way to establish its own outstanding record for year-in and year-out economies and reliable performance. It's the proven quality of Brown Boveri equipment *plus* low initial cost which has made it the choice of astute buyers.

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Note boiler feed piping, some covered with aluminum—turbine on left, generator on right enclosed in temporary sheds

BLAW-KNOX piping serves modern outdoor Parkdale Power Plant

More than 36,000 feet of piping, in sizes from ½" to 24", are required for operating the 100,000 kw #2 unit in the new modern outdoor Parkdale Power Plant of the Dallas Power & Light Company.

Part of the system consists of 830 feet of heavy alloy steel piping—1¼% chrome and ½% molybdenum—to carry main steam at a pressure of 1550 psi and a temperature of 1005° F. Of this piping, 800 feet is 10¾" OD x 1.563" wall thickness and 30 feet is 16" OD x 2.25" wall thickness.

Piping 2½" and above was shop fabricated by the Blaw-Knox Power Piping Division in Pittsburgh. Piping 2" and under was field fabricated. All of it was erected by Blaw-Knox, who maintained a supervisor on the site.

The designers and supervisory engineers for all construction were Ebasco Services Incorporated. Blaw-Knox was the prime piping contractor.

Always available to you are the same experience, skill and facilities of our Power Piping Division. Let us know your requirements and we'll provide the service you need.

To get more information on piping for industry, send for your copy of Bulletin No. 2443.

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Think of the saving in man hours that could be effected in a year's time by the use of LimiTorque—not to mention the elimination of key men climbing to out-of-the-way, often times hazardous locations of important valves . . . Then, too, when LimiTorque opens or closes valves, by the "*mere push of a button*", the valves are operated at just the correct speed . . . and if an obstruction is encountered in closing, LimiTorque shuts off the motor, thereby preventing any possible damage to the valve seats, stems, discs or gates.

LimiTorque is operating thousands of valves throughout the World . . . day and night, on land and sea, in hot and sub-zero climates, indoors and outdoors . . . *Speedily* — *Safely* — and *Dependably*. LimiTorque Motor Operated Valves are readily adapted to Microwave Control.

Photo above shows new installation in the City of Philadelphia water department high pressure fire pumping station, located at Delaware Avenue and Race Street. Seven LimiTorque Valve Control Type SM-1 are shown operating gate valves.

For further information send for Catalog L-54, and remember, *far more valves are operated by* LimiTorque than any other valve control.

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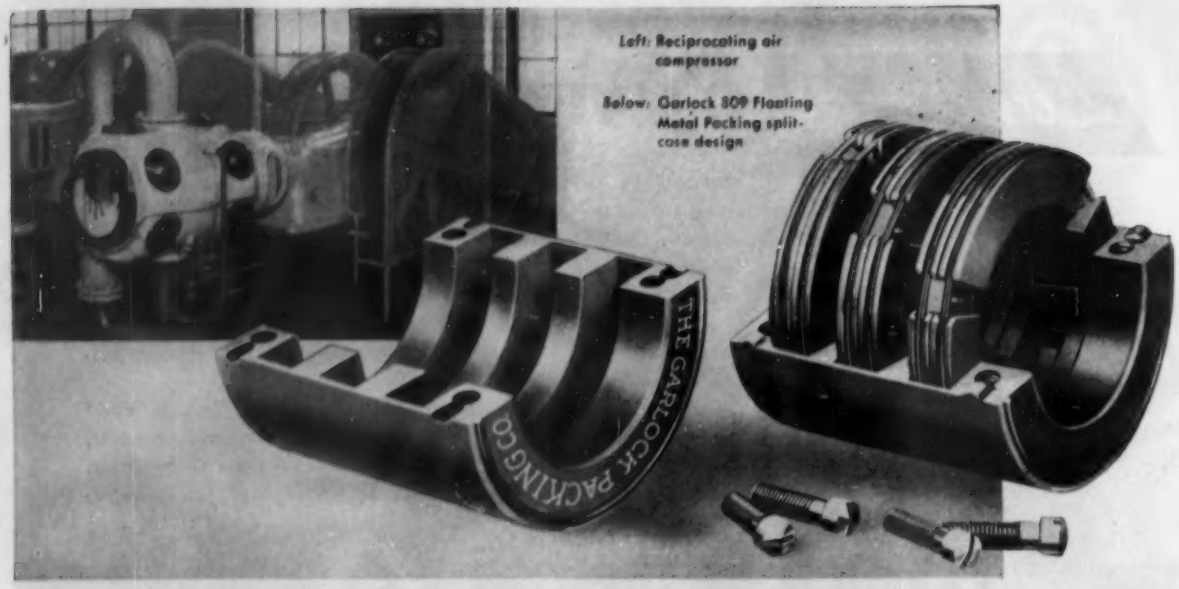
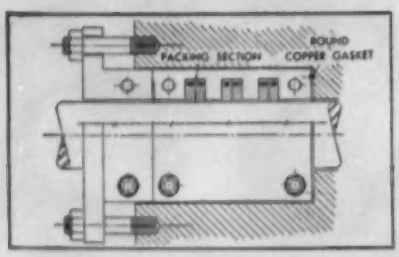


Left: Reciprocating air compressor

Below: Garlock 809 Floating Metal Packing split-case design

For air compressors, users report GARLOCK SPLIT-CASE METAL PACKINGS have 2 big advantages



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- On an electric-driven compressor, rod size 1¼", 277 r.p.m., operating continuously, Garlock metal packing has been in service 9 years with the original cast iron rings and only .002" rod wear.
- On steam-driven, variable-speed compressors in a power plant, Garlock split-case metal packings have operated satisfactorily for 15 years without replacement of any parts.

1. **LONG, TROUBLE-FREE LIFE.** Minimum of 7 years with proper lubrication.

2. **CAN BE INSTALLED *WITHOUT* DISCONNECTING THE ROD.** Downtime is reduced to a minimum.

You can eliminate the cost of frequent packing replacements and unnecessary downtime by installing Garlock split-case metal packings on your reciprocating air compressors. Service reports like those at the left, show that these Garlock metal packings have given 15 years *and more* of trouble-free service with a minimum of rod wear.

The minimum packing space for Garlock 809 split-case metal packing is ½". Garlock 805 (also split-case) can be used in smaller packing spaces since it is installed outside the stuffing box.

For complete information, call your Garlock representative or write today for Brochure 3889.

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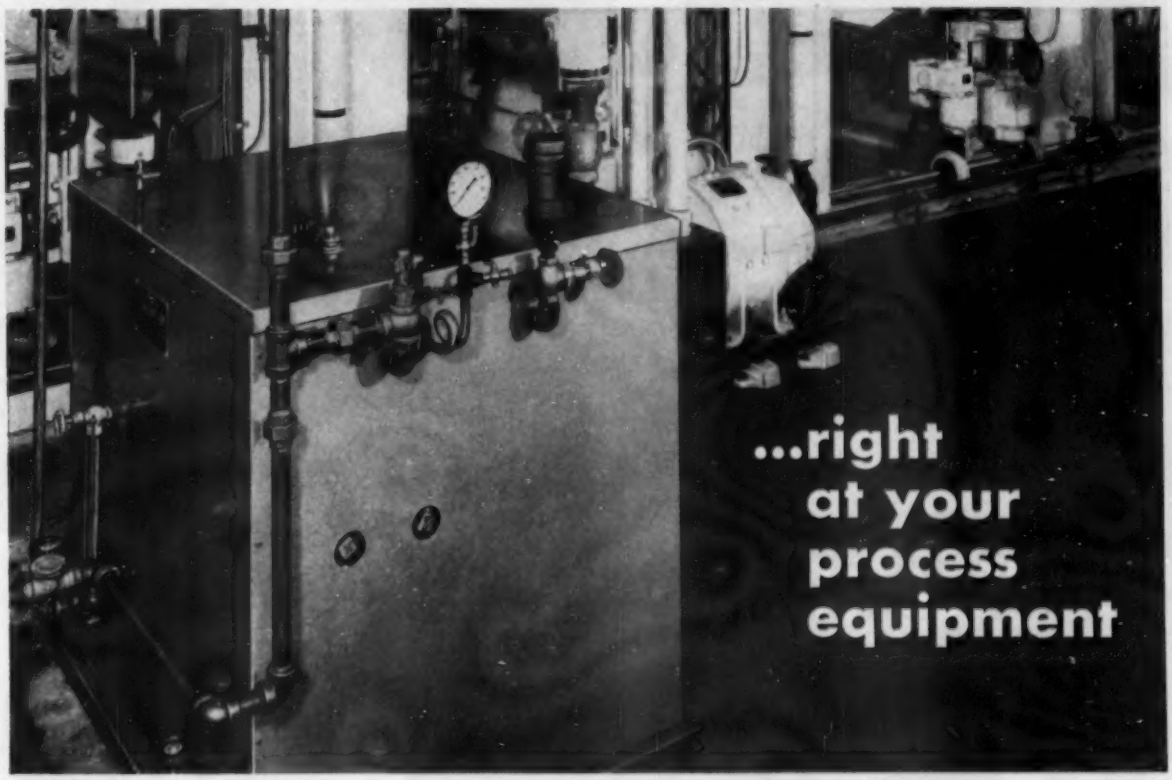

with a Pantex Speedylectric Steam Generator

Think of it! — Speedylectric lets you have constant temperature "dry" steam wherever you want it for as little as $685. Install it near your platen presses, or for degreasing, and phosphatizing, or on jobs that are remote from your central boiler. No fumes, no flame, no smoke-stacks or other complicated installation problems. Just plug in to either 220, 440 or 550v outlet, connect piping, and you have an ever-ready source of high pressure steam that you can control precisely.

Speedylectric utilizes the electrode principle — the simplest, lowest cost method for generating steam electrically. It has no coils, tubes or electric elements to scale and burn out. No feed water treatment or daily blow-down is needed. Equally important, Speedylectric is safe from fire dangers . . . no open flame or low water explosion hazards. (Underwriter's Laboratories Listing) 1½ to 60 Bhp; 15 to 500 Psi. Why not write for complete data and illustrated Bulletin.

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51 WAREHOUSES IN THE U. S., CANADA, AND FOREIGN COUNTRIES

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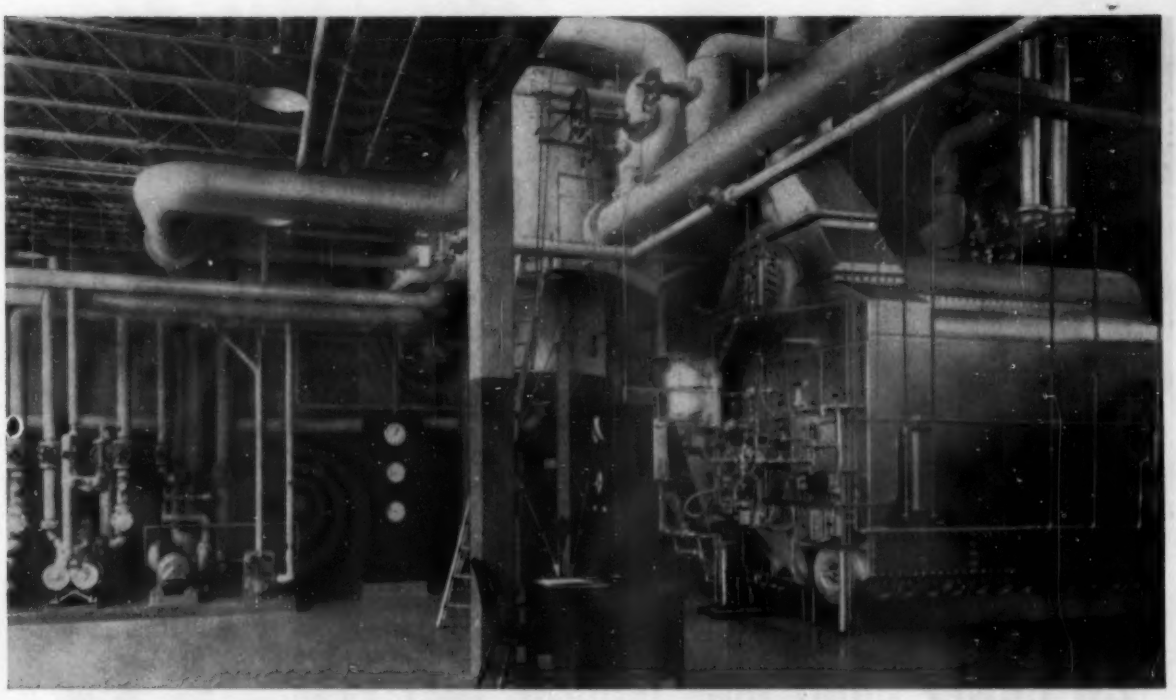


Union packaged boilers exceed 80% in efficiency tests at University of Toledo

Job Report (UIW)—Not only do two Union Type MH Packaged Steam Generators provide space heat for 14 buildings on the University of Toledo's 170-acre campus, but they also take part in the educational process. Utilized for laboratory work by mechanical engineering students, these Union Steam Generators are reported to operate at "better than 80% efficiency."

Says University of Toledo, "We get 128 lbs. of steam per gallon of fuel oil as compared to 93 lbs. per gallon with the old boilers formerly used. The new plant, in operation since the fall of 1953, uses #6 oil in the winter and #5 in spring and fall. During the past year, 361,746 gallons were used, producing 46,180,000 lbs. of steam."

Users who have kept tabs on Union Packaged Boilers as carefully as University of Toledo, report like economies. From coast to coast, Union Type MH Steam Generators have proved their worth in chemical processing plants, pulp and paper mills, breweries, refineries, institutions, schools and hospitals, to name a few.

Completely shop-assembled in Erie, Pa. for delivery via rail or truck, Union Type MH Units are patterned after larger but similar field-erected Type H Boilers, originated by Union over 16 years ago. They can be equipped to handle multitudes of needs formerly requiring costly field erection and special engineering.

For example: Superheaters can be installed to meet total temperature requirements, while air heaters and economizers are readily supplied when needed.

Standard units are designed in 13 sizes from 10,000 to 40,000 lbs. of steam per hour at 250 psi, with higher pressures available for special applications.

The complete story on Union Type MH Steam Generators, including cut-away illustrations, tube layouts and dimension tables, can be obtained promptly by requesting Bulletin MH-353 from Union Iron Works, Erie, Pa.

AT TOP: 28,000 lbs. of steam per hour—that's the capacity of this Union Type MH Packaged Steam Generator which operates at 125 psig with 180 degrees feed water temperature (one of a pair serving University of Toledo).

LEFT: Steam generating plant houses two Union Packaged Steam Generators to provide space heat for 6,000 students.

RIGHT: Cut-away view of Union Packaged Boiler reveals its symmetrical, 3-drum design; divided tube banks and tangent tube wall construction.

Two Goulds 2 x 3-9 Fig. 3305 two-stage centrifugal pumps on boiler feed service. These pumps are available in five sizes, with capacities to 1200 GPM, heads to 1000 ft.

These new pumps are designed to cut power plant maintenance costs

Eight special features, designed to insure maximum efficiency and long life, are *standard* in these new Goulds Fig. 3305 two-stage centrifugal pumps.

When you specify these pumps you get, *without extra cost:*

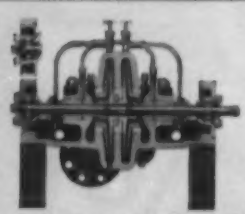
1. Renewable stuffing box bushings.
2. Bearing housings sealed against moisture and dirt.
3. Cowl-type glands suitable for use with quenching liquids.
4. Stainless steel impeller keys.
5. Teflon water-seal rings.
6. Die-formed stuffing box packing.
7. Corrosion-resistant gland bolts.
8. Unique labyrinth diaphragm which maintains thrust balance.

Every one of these features means less maintenance expense for you—less down time of vital equipment in your plant.

And that's not all, for the Fig. 3305 pump offers several other advantages, too. For example, you can choose either a conventional stuffing box or a mechanical seal, to suit your requirements, and you can change from one to the other at any time. Also, the exclusive Goulds patented locking shaft sleeve permits you to change the direction of rotation in the field, without additional parts.

Furthermore, if you use a number of pumps in your plant, the extensive standardization of parts enables you to keep your parts inventory low. Not only are many of the parts interchangeable within the various five sizes of the Fig. 3305 pump, but many parts also are interchangeable with those of the Goulds Fig. 3405 single-stage, double-suction pump.

Send the coupon below for Bulletin 722.6, which gives the complete story of the Fig. 3305 advantages, including specifications, performance curves, and interchangeability charts.



Cross section drawing of Fig. 3305 two-stage centrifugal pump.

GOULDS PUMPS, INC., Dept.PO-9,
Seneca Falls, N. Y.

Please send me Bulletin 722.6 giving details and specifications of Fig. 3305 two-stage centrifugal pumps. I understand that this places me under no obligation.

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IF YOU HAVE A CONVEYOR JOB HANDLING ABRASIVE OR CORROSIVE MATERIAL... *HERE'S YOUR IDLER!*

The Joy Limberoller idler installation shown above is in a magnesium foundry, supporting a 30″ belt which carries abrasive material up a 35° slope. *To date, these idlers have been on the job 10 times longer than conventional idlers previously lasted—and they're still going strong!*

ONLY 2 BEARINGS, UP OUT OF THE DIRT ...The Joy Limberoller idler consists of neoprene discs molded on neoprene-covered flexible steel cable. It is suspended from two bearings, one on each end, *out of the dirt zone.* This distinctive design, field-proved by thousands of idlers already in service, averts fouled idler rolls—protects the belt from damage—reduces your maintenance to a fraction.

OTHER ADVANTAGES, TOO . . . Joy idlers are self-training—they conform to the load with a cushioned grip which supports the loaded belt without slipping and reduces belt wear. They resist corrosion, abrasion, flame and grease—weigh ⅔ less than steel idlers, and handle bulk or packaged materials equally well. They're easily changed *without stopping the belt,* and compactly stored.

Whatever your belt conveyor job may be, let us help you to make it more efficient and economical. Joy Limberoller Idlers are available for belt widths of 18″, 24″, 30″ and 36″—and you'll find them easier, faster and less costly to install, maintain, knock down and move than any other conveyor idler on the market. ● ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WRITE FOR COMPLETE DETAILS

Ask for free *Bulletin LD-103C.* It gives complete information on the unique Limberoller Idler, and we'll be glad to supplement it with engineering assistance on your particular problem.

Consult a Joy Engineer

WBD 10690

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40 PAGES of helpful information

on Recovering Dusts, Fly Ash, Mists, Fumes and other Suspensions from Gases.

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the important points design and plant engineers should know about Cottrell Precipitators . . .

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- Principal elements in a Cottrell unit.
- Data on Mechanical and Electronic Rectifiers.
- Various types of Collecting Electrodes (rod curtains, corrugated plates, pocket electrodes, etc.).
- Typical ways of removing collected material.
- Various Shell Constructions (steel, concrete, brick, etc.).
- The effect of various factors on efficiency and performance.
- Data on CMP (Combination Multiclone-Precipitator) Units.

. . . and many other helpful facts on Cottrell design and operation.

Latest data from Western Precipitation on Cottrell Recovery Equipment

Do you have operations in your plant where gas-laden suspensions, wet or dry, are a problem? Such suspensions may be dropping on surrounding property, causing nuisance difficulties. Or perhaps important values are being lost in stack gases that can be profitably recovered. Whatever the nature of your recovery requirements, you will find this 40-page Cottrell booklet of great help. It contains up-to-date data on the latest advancements in the electrical precipitation field – prepared by the organization that pioneered the commercial application of Cottrell Electrical Precipitators almost a half century ago and has consistently led in new Cottrell developments.

A copy of this data-packed booklet will be sent free to engineers and other executives interested in recovery processes. Send your request to our nearest office.

For nearly 50 years Western Precipitation has carried on a continuous research and development program on Cottrell Electrical Precipitators, Multiclone Mechanical Collectors and other types of recovery equipment. We are not affiliated with any other company in the electrical precipitation field except our wholly owned subsidiaries, International Precipitation Corporation and the Precipitation Company of Canada, Ltd. We are equipped to serve you anywhere in the United States, Canada, and throughout the world!

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SAVES OUTAGE TIME AND MONEY

Tradename "Guniting" courtesy Cement Gun Company, Allentown, Pa.

. . . "GUNITING" WITH Super ADACHROME-CAST

Use SUPER ADACHROME-CAST to gunite your stud tube water walls—Fine-grained to penetrate the small apertures between studs—packs to a dense mass when shot. One user reports SUPER ADACHROME-CAST lasted twice as long and took but one-third the time to apply as compared with a plastic chrome ore installation. Excellent for coating brickwork when free of slag.

HERE'S THE RIGHT COMBINATION FOR LONGER FURNACE LIFE...

ADAMULL FIRE BRICK AND ADAMANT FIRE BRICK CEMENT

The photo at right shows a large, oil fired furnace . . . completely rebuilt with ADAMULL Super Duty Fire Brick and bonded with famous ADAMANT Fire Brick Cement . . . this combination insures **longer furnace life** despite high temperatures and extreme spalling conditions.

ADAMANT Cement: Greater bonding strength protects the structure at the joints, where failure usually begins . . . therefore, linings last longer; production is maintained, repair costs and production materials saved; less "outage."

ADAMANT—Ready-Mixed and Easy to Use—available in air-tight drums of 100, 250 and 500 lbs. capacity.

ADAMULL Fire Brick: A super duty fire brick for use in furnaces operating at high temperatures and for the "tough spots" in all furnaces.

ADAMULL super duty brick will withstand more temperature, more slagging, more heat shock than first quality fire brick, and meets the A.S.T.M. specification for Super Duty Brick.

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Using these newly designed anchors, all that may be required are lengths of 1½" O.D. pipe for hanging the roof tile . . . or as spacers behind the wall clip for 13½" and 18" walls. (Pat. applied for)

Write for literature . . . and the name and address of your nearest BOTFIELD Industrial Distributor.

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Wherever Disaster Strikes...

The beautiful Hospital San Carlos, Bogota, Colombia, one of the finest in South America, is equipped with Kewanee Boilers.

Architect: Cuellar, Serrano, Gomez & Co. Ltd.; Consulting Architect: Smith, Erickson & Gardner; Engineer: Cuellar, Serrano, Gomez & Co. Ltd.

Two No. 588, 125 lb. Kewanee Boilers installed in the Hospital San Carlos in Bogota, Colombia. They assure power expansion when needed—an important factor when the lives of patients are at stake.

HOSPITALS THE WORLD OVER DEPEND ON

KEWANEE reserve plus rated boilers

WITH 50% EXTRA POWER

WHEN steam power may mean life or death to hospital patients . . .

WHEN emergencies demand maximum temperature, split-second sterilization of instruments . . .

WHEN unfailing power is needed to bring light to the delicate techniques of modern surgery . . .

WHEN the operating rooms of hospitals are theatres of extreme urgency . . .

That is when Kewanee Reserve Plus Rated Boilers become a necessity—because they have the reserve power for additional capacity requirements.

With a rating plan based on the commercial code of the Steel Boiler Institute, Kewanee Boilers certify 50% or more extra built-in power. This extra power assures the ability to treat more sufferers when epidemics or disaster strike. Modern hospitals must have the foresight to prepare for major disasters such as earthquakes, tornadoes, fires and accidents which bring masses of emergency cases to the operating rooms.

Kewanee Boilers, rated on nominal capacity with built-in reserve, can take care of expanding loads created through disaster. They offer "cruising speed" operation which means savings on fuel and repairs. Choose Kewanee and be prepared if disaster strikes.

You can depend on KEWANEE engineering

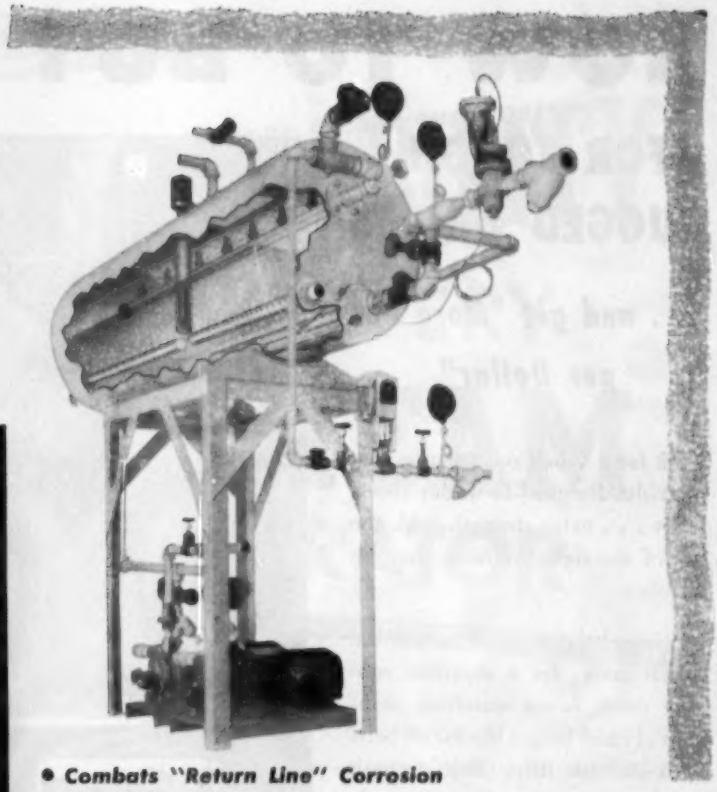
Now

"Budget-Priced" CORROSION PROTECTION

for the Small to Medium Steam Plant

The New

SCHAUB "03" Deaerator



- **Combats "Return Line" Corrosion**
- **Simpler in Principle**
- **Gives Positive Oxygen Removal to .03 CC/Liter**

It is in plants of 3,000 to 30,000 lbs/hr boiler capacity — often operating at low pressure — that "return line" corrosion is most apt to rear its ugly head. This happens even when raw water make-up is negligible.

The Schaub .03 Deaerator was designed especially for these plants. It offers an effective and economical way to "clean up" boiler feedwater that will pay for itself many times over. It is equally applicable to high pressure installations.

The *big* difference in the Schaub .03 Deaerator is that it operates fully vented at *atmospheric* pressure. Noncondensible gases escape *immediately* and *completely*. Premium cost construction is eliminated, maintenance and operating costs are reduced to a minimum. Simple but effective spray-contact vent condensing prevents wasteful steam vapor loss. Pin-point temperature control, "live action" heating, and rust proof Chromasoid lining are exclusive features.

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Write for Bulletin 1300 — and the full story on this low-cost, more efficient Deaerator.

Simple as it is, there's a lot more to the Schaub .03 Deaerator than can be told on this page. Bulletin 1300 is filled with facts for the operating or consulting engineer responsible for boiler feedwater deaeration. It tells the "hows" and "whys", and the basic differences in the Schaub .03 method. Mail the coupon now. No obligation, of course.

NOTE: The Schaub .03 Deaerator is designed for boilers up to 1,000 HP, or 30,000 lbs. per hour. For capacities up to 100,000 lbs. per hour at .005 cc/liter "zero-oxygen" removal, write for Bulletin 575, describing the Schaub Zero-Oxygen Deaerator.

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Please send me, without cost or obligation, my personal copy of your new Bulletin 1300 on Boiler Feedwater Deaeration.

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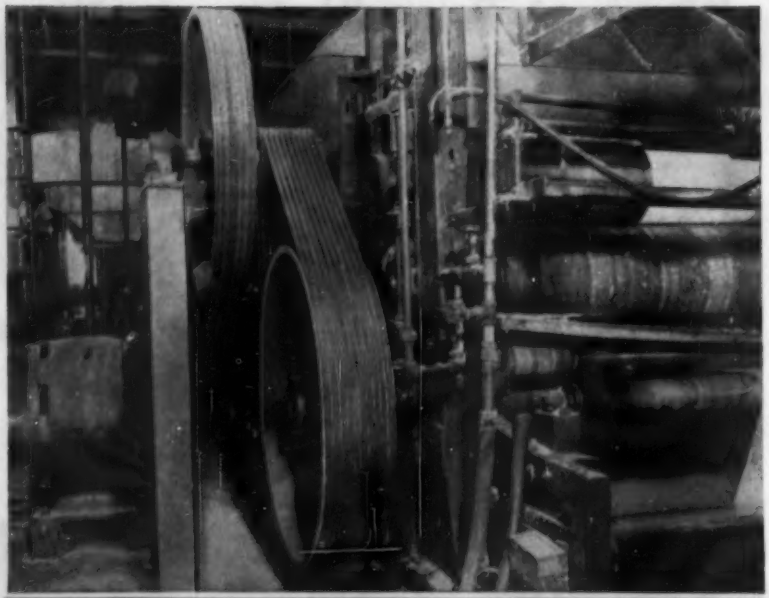
FOR TOUGH, RUGGED DRIVES

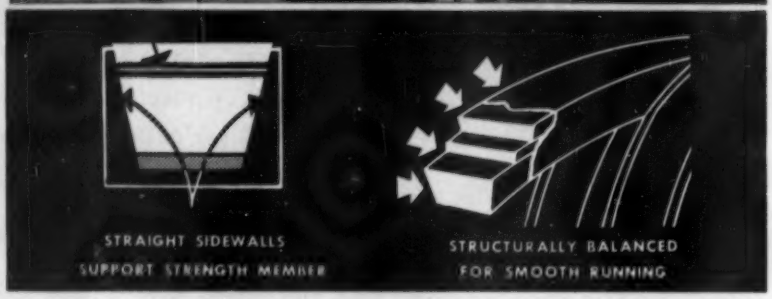
. . . and get "More Use per Dollar"

Look for a V-belt construction that provides longer life under shock loads . . . extra strength with the use of the right synthetic strength member.

Precision balance of all parts of the V-belt makes for a smoother running drive, fewer matching problems . . . and longer life for all belts on a multiple drive. Belt strength members of super-strength cords should be correctly positioned in the neutral axis section of the belt so as not to stretch or compress unnecessarily as the other parts of the belt are flexed in use. Straight belt sidewalls help support strength members in a straight line, permit all cords to pull equally . . . deliver their full share of power. You get more grip, less slip because the belt presses tightly against the sheave grooves when rounding pulleys.

Specify by name the V-belt engineered to give you extra strength and extra pulling power . . . specify R/M Super-Power V-Belts.





R/M SUPER-POWER V-BELTS

With these superior V-belts you get up to 40% more power capacity, or fewer belts can be used on the same drive, thanks to R/M's new synthetic super strength member. They provide greater elastic resistance to shock loads and permit virtually no stretch. R/M Super-Power V-Belts are oil-proof, non-spark, heat resistant. You get the balanced combinations of features you need for more power on rugged multiple drives. Let an R/M representative show you how R/M Super-Power V-Belts, as well as Condor V-Belts, last longer on the job . . . give you "More Use per Dollar".

RM-912

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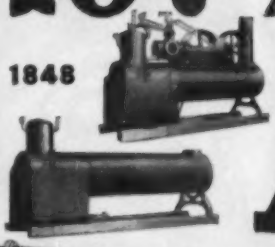
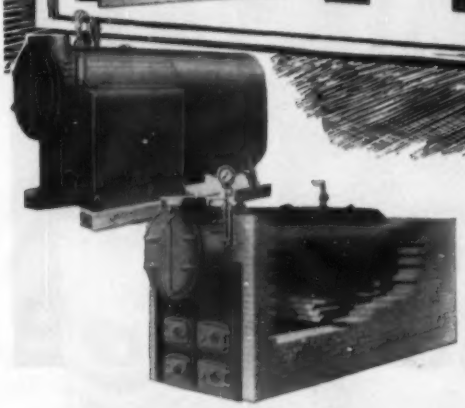
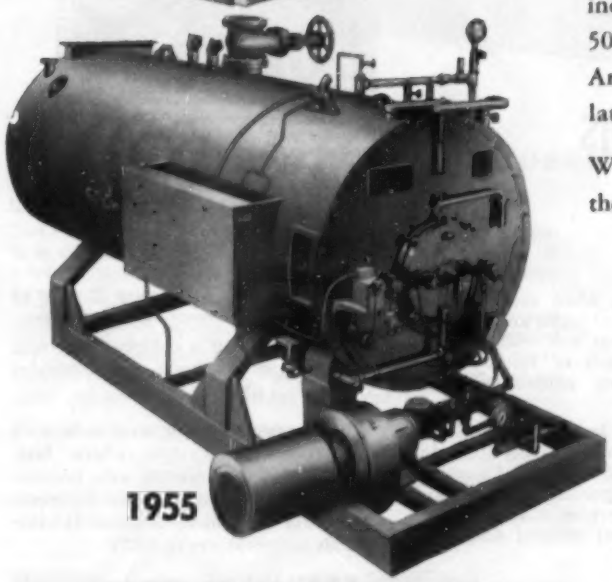
107 YEARS of RELIABILITY ARE BEHIND EVERY AMESTEAM GENERATOR







AMESTEAM GENERATOR

20 sizes, 10 to 600 H.P., 15 to 200# W.P., oil, gas, or oil-gas combinations with quick fuel switchover feature.

In your selection of a boiler, it's important to remember — experience *does* count. And what better assurance of top boiler quality do you have than the Ames record: 107 years of building fine boilers — boilers which have given economical, satisfactory service throughout the industry! Many Ames units purchased 40 to 50 years ago are still faithfully on the job. Amesteam Generators always incorporate the latest advances in package boiler design.

Write today for details on these boilers with the proven record of reliability.

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Show me how I can benefit from Ames experience and nation-wide organization in getting a top boiler value.

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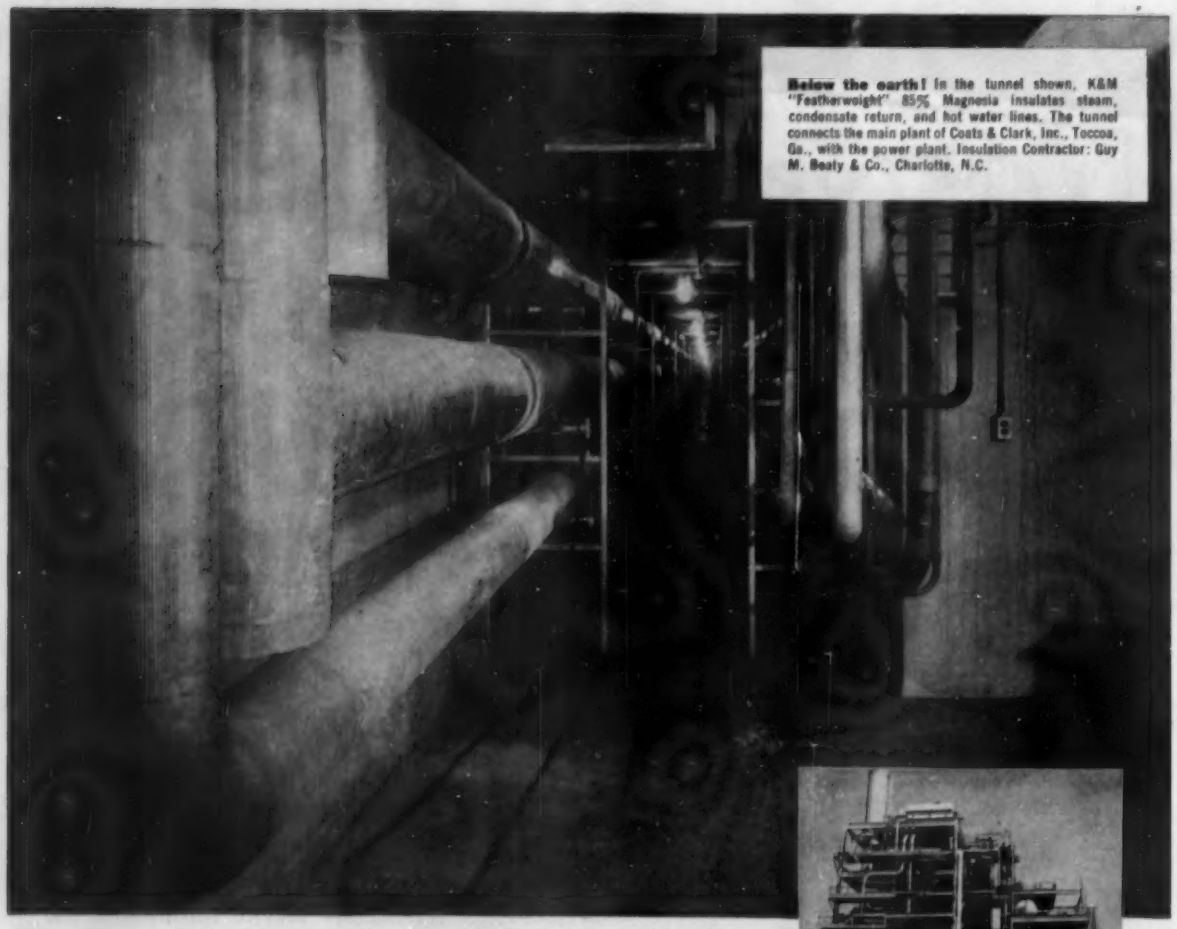
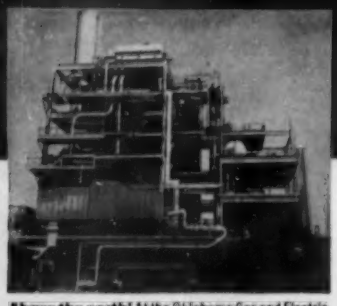


Below the earth! In the tunnel shown, K&M "Featherweight" 85% Magnesia insulates steam, condensate return, and hot water lines. The tunnel connects the main plant of Coats & Clark, Inc., Toccoa, Ga., with the power plant. Insulation Contractor: Guy M. Beaty & Co., Charlotte, N.C.



Above the earth! At the Oklahoma Gas and Electric Company's plant in Sulphur, Oklahoma, K&M "Featherweight" 85% Magnesia insulates equipment exposed to the elements.

Underground or far aloft— K&M high pressure insulations save dollars by saving heat!

Wherever they're used, K&M insulations give efficient, heat-saving service. K&M "Featherweight"® 85% Magnesia—used on the steam lines in the tunnel shown above—lasts the life of the equipment it serves. It withstands moisture, vibration, and frequent temperature changes. Supplied in various sizes and thicknesses, it's frequently used in combination with another outstanding Keasbey & Mattison high pressure insulation—K&M Hy-Temp.

These materials, when used together, and applied so that joints are staggered, eliminate the heat loss that normally occurs in single-layer installations—particularly when expansion causes joints to open.

For efficiency to 1900°F. — K&M Hy-Temp Insulation. Usually applied in combination with K&M "Featherweight" 85% Magnesia. This material is made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber.

For efficiency to 600°F. — K & M "Featherweight" 85% Magnesia. 85% of this insulation is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

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All K&M high pressure materials assure you dependable, economical insulation—be sure to keep them in mind! For additional data—and the name of your K&M distributor, who is also an experienced applicator—write directly to us.

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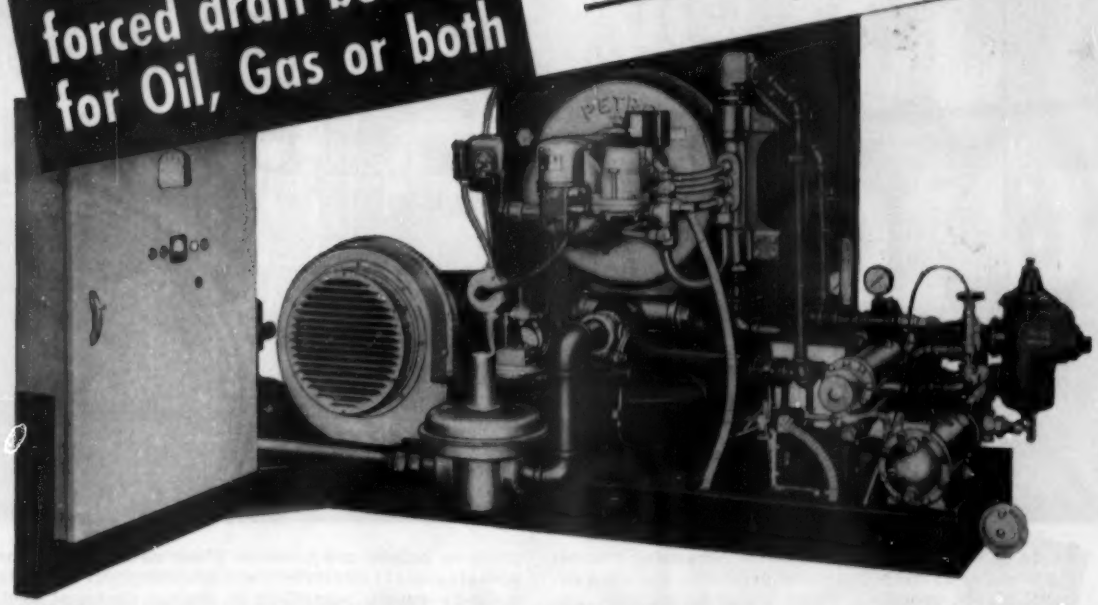
HERE'S BOILER ROOM ECONOMY
from the word "GO"

Petro
forced draft burners for Oil, Gas or both

A COMPLETE FIRING SYSTEM IN A SINGLE PACKAGE



Quickly converts your present boiler to automatic firing

LOW FIRST COST

This Petro package unit is much more than a conversion burner. It is a *complete* combustion system in which all elements are correctly balanced—and integrated—a thoroughly engineered firing plant.

Includes burner (for oil, gas or combination oil-gas), fuel system, forced draft air supply, control panel, and preformed refractory combustion throat. Installation requires little more than bolting the entire unit to the boiler-front, and making safety and service connections for power and fuel.

ENCLOSED CONTROL PANEL

Neat, safe, and complete—the Petro control panel is totally enclosed with all instruments wired and tested at the factory. Can be attached to frame as shown, turned 90° or 180° or mounted elsewhere in the boiler room.

LOW FUEL COST

OIL—Petro's highly efficient horizontal rotary oil burner is adaptable to the entire range of fuel oil grades. Exclusive Petro Thermal Viscosity System automatically heats the heavier oils before injecting into atomizing cup. Assures quick pickup with sure and economical firing of lower cost fuels.

GAS—Designed for all types of gas—high or low pressure—the Petro circular arrangement of multiple gas jets provides a thorough mixing of gas and air *ahead* of the combustion zone. A real fuel saver. Adaptable to steady or fluctuating load requirements.

COMBINATION OIL-GAS—In one compact unit. Gives alternate stand-by fuel and permits taking advantage of fuel price fluctuations. Fuels can be switched in a matter of seconds.

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Over 50 years of leadership in automatic heating and power equipment

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Please send me literature and specification sheets on the money-saving Petro Package Unit.

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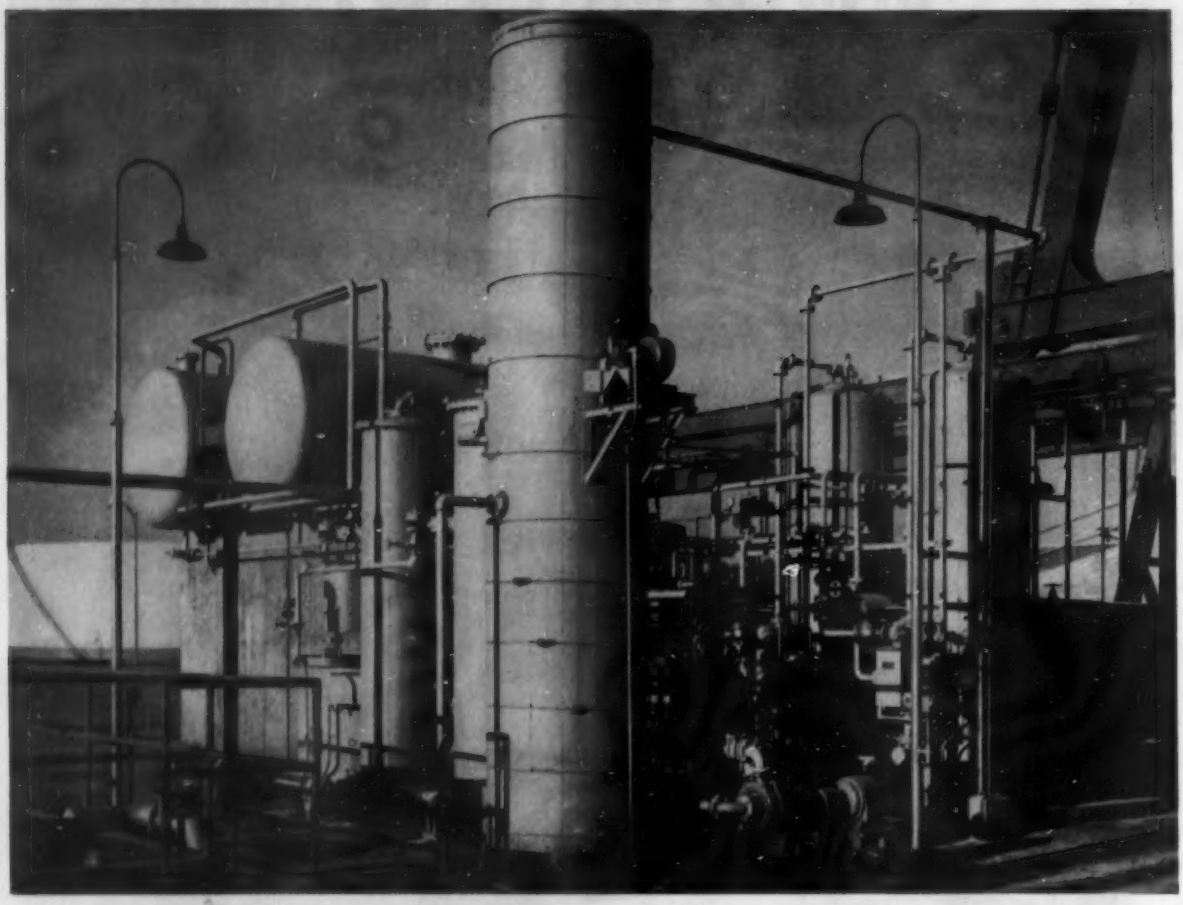
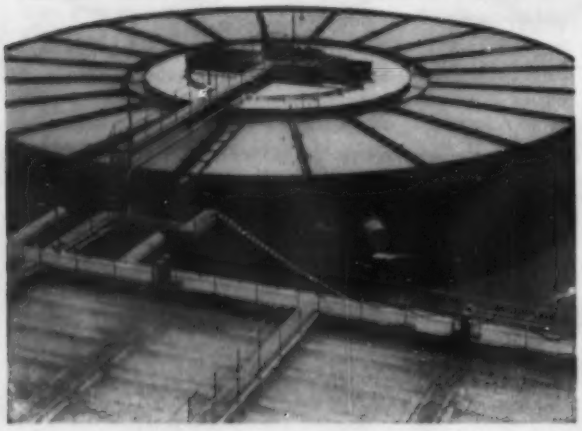
3 SOLUTIONS FOR YOUR BOILER FEEDWATER PROBLEMS



1. CATEXER® and ANEXER® Demineralizing Plants: Pioneered by INFILCO, these demineralizing and silica removal plants, operating on the ion exchange principle, provide the low solids and low silica content water so necessary to the satisfactory operation of very high pressure boilers and turbines. They afford five major advantages: (1) improved make-up quality, (2) adequate make-up supply regardless of station electrical load, (3) reduced overall operating costs, (4) lowered maintenance costs and (5) lower labor costs.

2. ACCELATOR® Treating Plants: The "ACCELATOR" treating plant with appropriate chemical feeding equipment and auxiliaries affords in many cases a satisfactory means of treating feedwater for low pressure boilers or for pretreating feedwater for higher pressure boilers. They have a proven record of flexibility, ease of operation and chemical economy.



3. Hot Process Softeners: For the intermediate range of boiler pressures, INFILCO Hot Process Softeners with Hot Process Zeolite Units provide low alkalinity, low hardness and low silica content feedwater at moderate chemical cost.

Engineering Experience: Complete engineering know-how plus many years of experience has made INFILCO the leader in its field. Our field engineers are available to suggest practical solutions for your feedwater problems. Write today for complete information to

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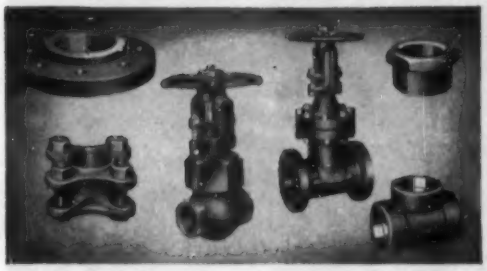
Field offices in principal cities in North America

INFILCO

The one company offering engineered equipment for all types of water and waste processing—coagulation, precipitation, sedimentation, flotation, filtration, ion exchange and biological treatment.

Designed for today's *Tough* service demands



DROP FORGED VALVES AND FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

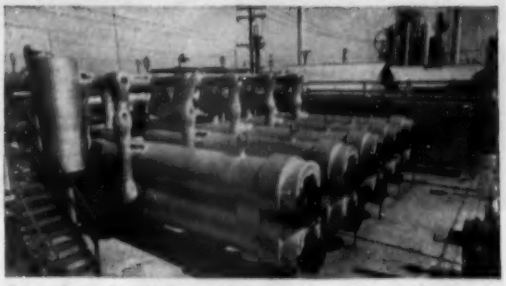
Drop forged from carbon and alloy steels, Vogt valves, fittings and flanges will safely handle liquids and gases at high pressures and high temperatures in power plants, chemical plants, petroleum refineries, etc. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees, and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and welding heads.

MODERN STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels meet every power, process or heating requirement.

PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.



SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.

MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Absorption Systems, Compression Systems, and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants, and institutions, here and abroad.

Vogt

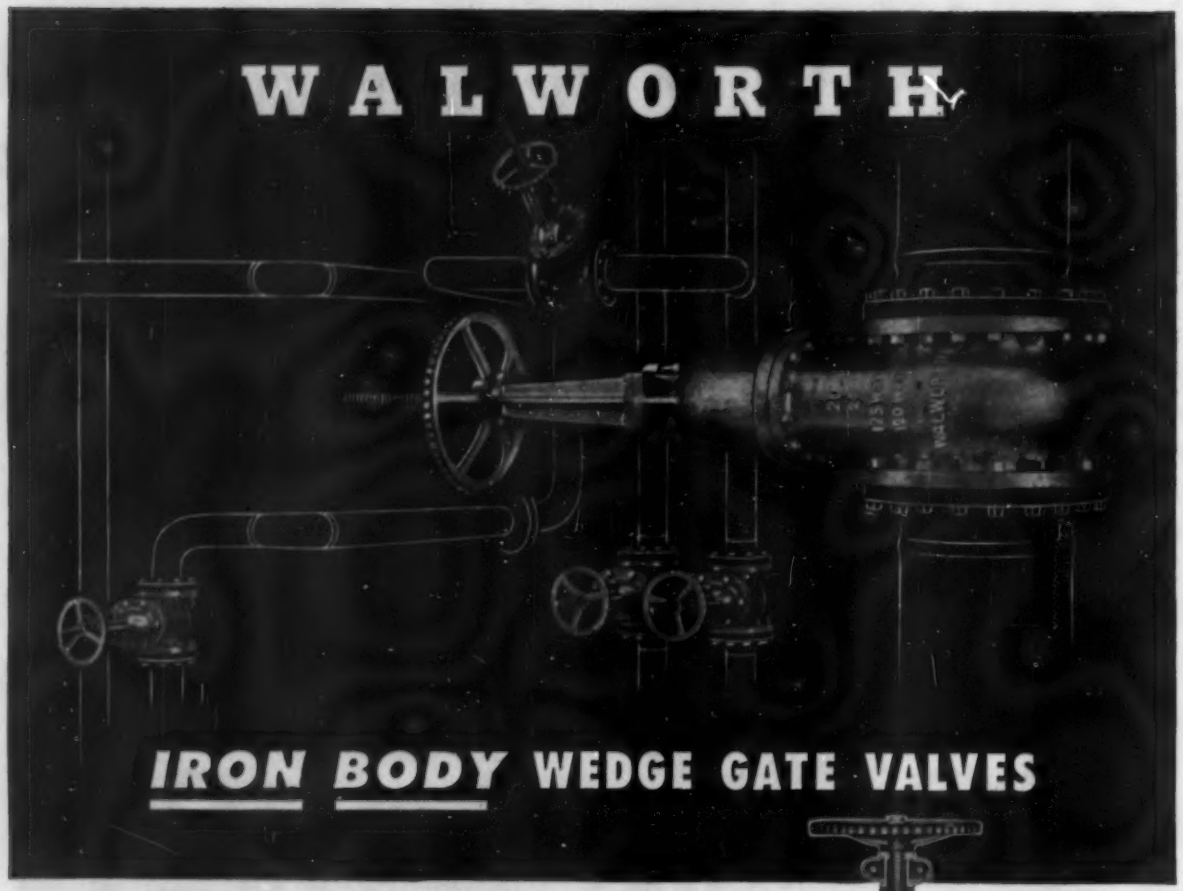
PRODUCTS

FOR REFINERIES, CHEMICAL PLANTS POWER PLANTS AND PROCESS INDUSTRIES

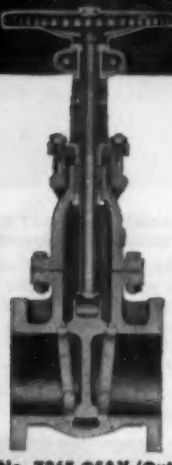
HENRY VOGT MACHINE CO.
LOUISVILLE 10, KY.

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland St. Louis, Dallas, Charleston, W. Va.

WALWORTH



IRON BODY WEDGE GATE VALVES



Walworth No. 726F OS&Y (Outside Screw and Yoke) Iron Body Wedge Gate Valve. OS&Y valves are recommended for services where it is desirable that the line fluid does not come in contact with the stem threads. Note the swing-type gland-eye-bolts for easy repacking. Sizes 2 to 30 inches.

Better because ...**The entire valve, from handwheel to seat rings, is ruggedly constructed to withstand rough and frequent usage. Body, bonnet, and yoke are sturdy castings with large radius fillets. Dimensions and drilling of end flanges are in agreement with American Cast Iron Flange Standards. Stiffening ribs connect end flanges with the body neck to maintain a rigid connection with piping.**

A wide range of Walworth Iron Body Wedge Gate Valves is available—through your Walworth Distributor—from which you can choose the right type to meet your most exacting conditions. Saddle-type valves as small as ¼-inch; low pressure valves for water and gas pipelines up to 36 inches.

Whenever you need valves and fittings, choose from complete lines—in a variety of metals—manufactured by Walworth. For more information, see your Walworth Distributor or write: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

APPLYING ATOMIC POWER?

Call on Solar skills with special metals for design and production of nuclear industry components

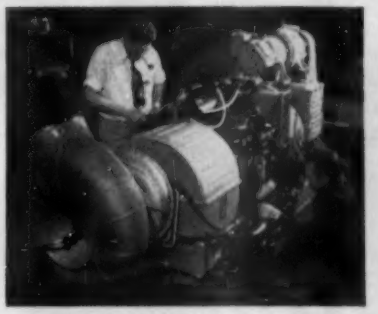
BUILDING FOR THE ATOMIC AGE calls for many special skills. For 28 years, Solar has been solving the problems that today confront nuclear engineers—extreme pressures, intense temperatures, corrosive conditions. Solar overcomes these hazards with highly precise fabrications of stainless steels, super alloys, titanium and other metals. This knowledge—expressed both in top quality contract production, and in the varied Solar proprietary lines—is now available to business firms and government agencies in the nuclear field.

SOLAR BELLOWS for an AEC installation are shown below. They are one of several components being built currently for nuclear processes. In production they demanded strict surface perfection. The stainless steel nacelles pictured at bottom call for the expert forming and exact welding of half and full hard stainless steels.

Surface perfection required for AEC use

CURRENT PRODUCTION at Solar also includes pneumatic ducting, aircraft engine components and varied hard-to-build items for the petroleum, chemical and power industries where many of the problems of nuclear processes have been encountered.

Solar builds first stainless nacelles



Jupiter gas turbine is light, compact

GAS TURBINE ENGINES designed and built by Solar include the 50 hp Mars® and the 500 hp Jupiter. Their simplicity, ease of maintenance, high power output in relation to size and weight, and versatility make gas turbines the ideal prime mover for many specialized applications.

PROTECTIVE COATINGS developed by Solar have proven useful in extending the service life of alloy metals in cases where intense temperatures and highly corrosive conditions previously presented design limitations.

SOLAR OFFERS MORE than metal working skills and special products for atomic installations. A comprehensive research organization, and design, development and production engineering groups supplement manufacturing facilities. Solar research and engineering "firsts" include the first practical jet engine afterburner, the first hand started gas turbine engine, the first proprietary line of ceramic coatings for high temperature service, and many others dating back to the first stainless steel aircraft manifold.

PRODUCTION FACILITIES cover every type of metalworking—forming, machining, welding, brazing, casting, coating. Equipment ranges from precision experimental and tool shop machines to specially designed high production units. Solar has designed and built many of its own welding and fabricating machines for specialized needs. Some have proved so useful that they have been ordered by firms in the United States and Europe.

Research facilities include 19 test cells

Engineering task force studies control devices

COMPLETE QUALITY CONTROL—to meet rigid aircraft and commercial standards—plus government source inspection, assures products that meet specifications. Solar plants in San Diego and Des Moines have 1,400,000 sq ft of floor space and thousands of skilled employees.

LET SOLAR PROVE how its skills are "tailor made" for the production of nuclear industry components. Describe your requirements, and let a Solar task force demonstrate that Solar is your logical supplier.

SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

INFORMATION

For more information regarding any Solar product or service, write Solar Aircraft Company, Dept. B-57 San Diego 12, California

How to Select an Economical Temperature Regulator

First of all, what does economy mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you could expect so much. And perhaps you didn't realize that *Spence* Temperature Regulators offer all these features and more. May we send you our Bulletin T 500 containing further details? **os 150**

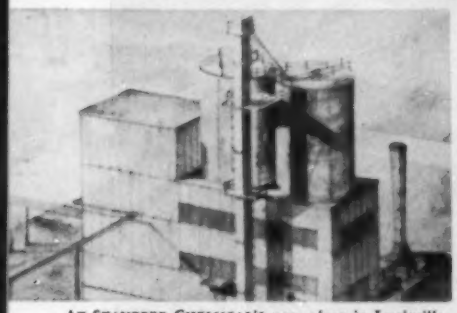
SPENCE ENGINEERING COMPANY, INC.
Walden, New York

DUPONT'S Barksdale, Wis. Works saves $7,000 a year with new automatic combustion controls.

HUDSON MOTORS' modernized plant in Detroit saves $480,000 a year—cuts powerhouse labor 27%.

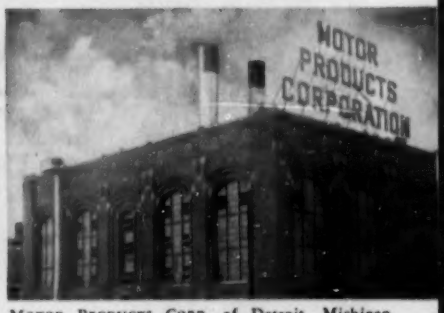
SYRACUSE UNIVERSITY, N. Y., built a completely new unit for maximum economy and dependability.

For efficiency... for economy...



AT STAUFFER CHEMICAL'S new plant in Louisville, Ky., total cost of steam is only 60¢ per 1,000 lbs.

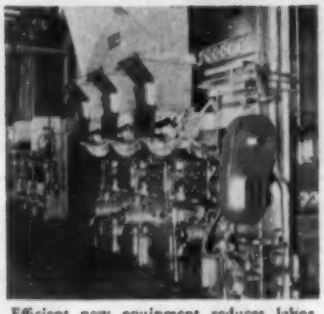
Coal costs 29.6% less than next cheapest fuel at ADDRESSOGRAPH-MULTIGRAPH'S plant in Cleveland.



MOTOR PRODUCTS CORP. of Detroit, Michigan, saves $54,000 a year with modernized installation.

more and more firms

Burning coal the modern way saves PENNSYLVANIA RAILROAD'S, Ft. Wayne, Ind. terminal $33,000 a year.



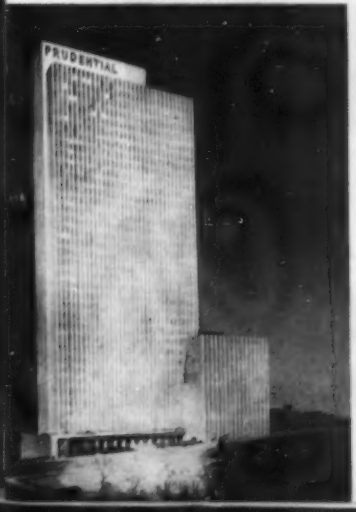
Efficient new equipment reduces labor and improves performance records for LIGGETT & MYERS at Richmond, Va.

AT LAKEWOOD HOSPITAL, in Lakewood, Ohio, new automatic coal burning facilities cut fuel costs 22%.

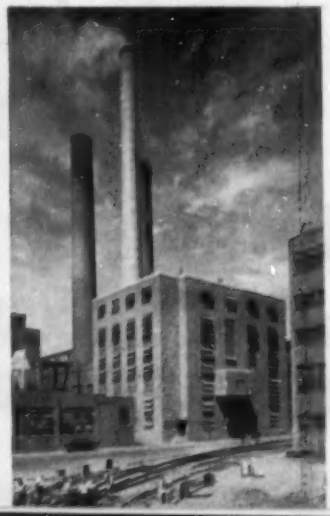
UPJOHN'S new Kalamazoo, Mich. plant is clean and efficient with no dust or smoke nuisances.

are burning coal the modern way

Chicago's ultra-modern PRUDENTIAL BUILDING has fully automatic coal handling and burning system.



GOODYEAR saves $3,000 a day with new coal-burning installation at Akron, Ohio.

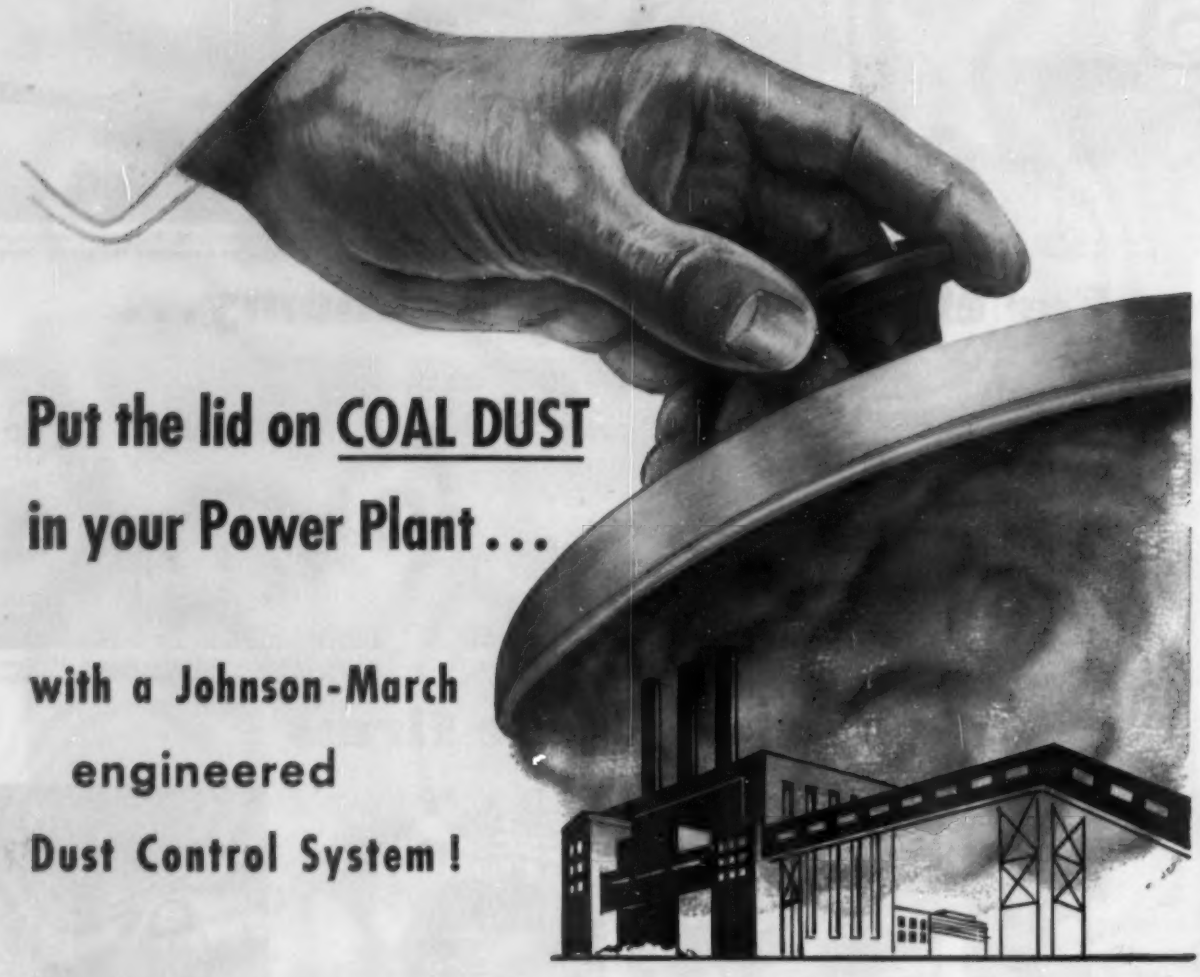


facts you should know about coal

- In most industrial areas, bituminous coal is the lowest-cost fuel available.
- Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.
- Automatic coal and ash handling systems can cut your labor cost to a minimum.
- Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.
- Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D. C.



Put the lid on COAL DUST in your Power Plant...

with a Johnson-March engineered Dust Control System!

Here's the simplest, most economical way you can stop dust in your power plant. A Johnson-March engineered dust control system stops coal dust wherever it occurs—at car dumpers, crushers, hoppers, belt galleries and coal piles... as well as dust created in fly ash handling and disposal.

Low-cost liquid dust control systems require almost no maintenance—cost only 1/10 as much as most other dust handling systems. No costly ducts, hoods or fans to interfere with normal operations.

Join the many leading power plants that have solved maintenance problems due to coal dust... fire and explosion hazards... community dust nuisance problems... safety hazards... with economical Johnson-March engineered dust control systems.

Even if you now have a mechanical dust collection system, let Johnson-March engineers show you how it can be improved at low cost. For a fast, sure solution to your plant and community dust problems, fill in and mail this coupon today.

THE JOHNSON-MARCH CORP. P
1724 Chestnut St., Philadelphia 3, Pa.
At no obligation, please
☐ Send informative data on J-M dust control systems.
☐ Have an engineer analyze our dust problem at no obligation.

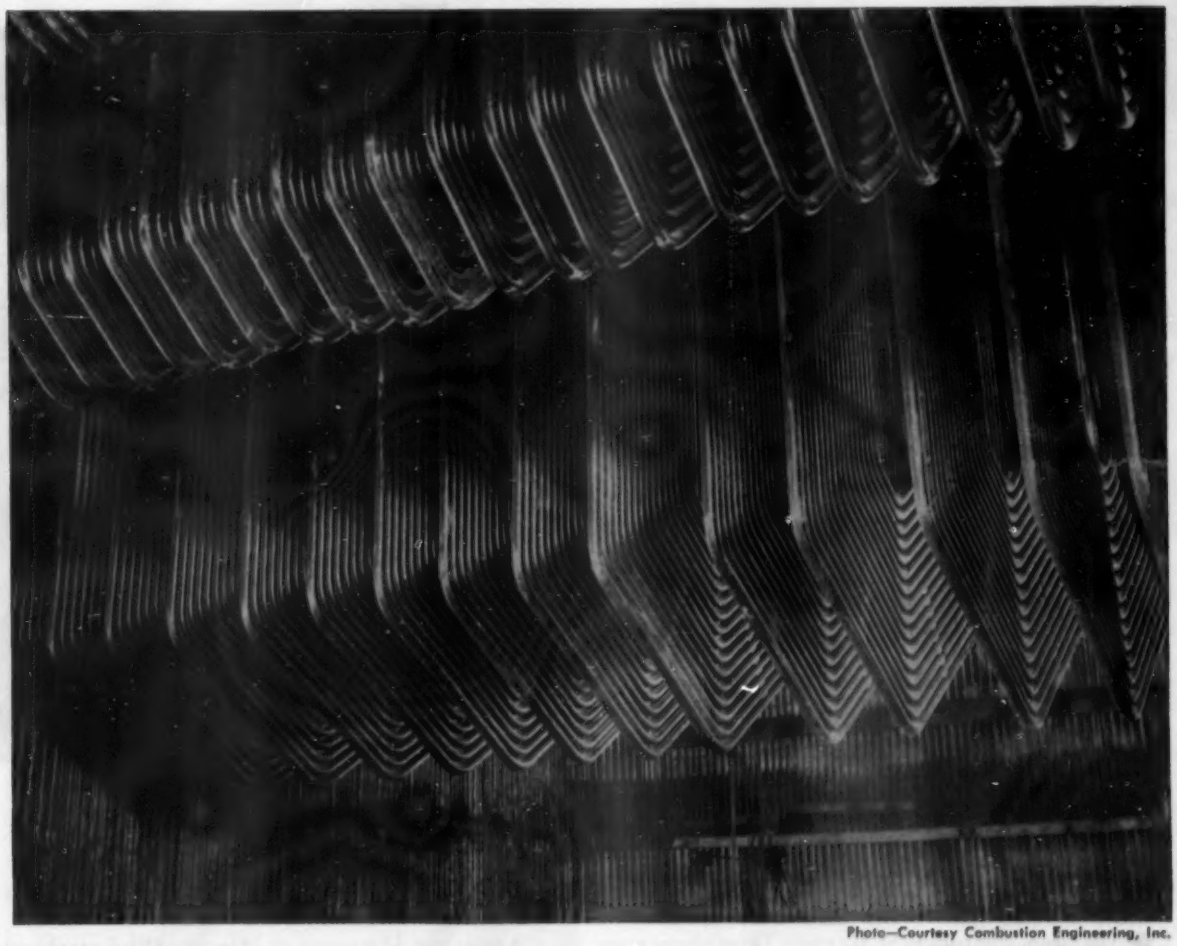
NAME..... TITLE.....
COMPANY.....
ADDRESS.....
CITY..... STATE.....

Johnson March

Dust Control Engineers

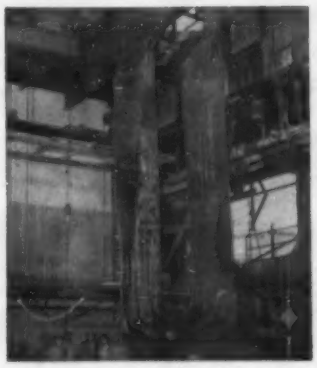
1724 CHESTNUT STREET, PHILADELPHIA 3, PA.

CANADIAN REPRESENTATIVES: G. F. Sterne & Sons, Ltd., Brantford, Ontario



Photo—Courtesy Combustion Engineering, Inc.

49 Miles of NATIONAL SEAMLESS



One of the huge superheater coils being hoisted into position.

. . . make up this giant superheater. And it's only a small portion of the total tubing used in this huge modern boiler. Here, steam at more than 2000 psi is superheated to 1000F. Severe as this duty is, it poses no problem for *seamless* tubes which, in fact, have been built to withstand much higher pressures and temperatures.

USS NATIONAL Seamless Pipe and Tubes are chosen almost invariably by designers and power engineers for boilers and high-pressure steam lines. They specify National Seamless as they always have in the past—secure in the knowledge that NATIONAL promises long, safe, and satisfactory service.

Even under the severest operating conditions, NATIONAL Seamless Pipe and Tubes have never been excelled for safe, efficient power plant service. Pierced from solid billets of steel, they have the strength, uniformity, and dependability of solid forgings. Each length is an homogeneous steel cylinder with uniform wall strength throughout, designed to remain structurally sound under high temperatures and tremendous pressures.

For full details on the use of NATIONAL Seamless in power installations, write for Bulletins 10 and 26. Or, if you're planning an installation, and would like some help, let our engineers give you a hand.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

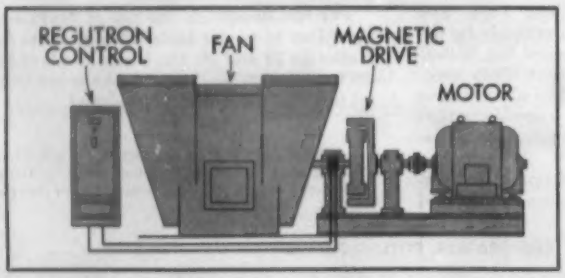
NATIONAL Seamless PIPE AND TUBES

UNITED STATES STEEL

Now 18 E-M Magnetic Drives for Potomac Electric Power Company

● The clean, compact E-M Magnetic Drive above gives adjustable speed for an induced draft fan at the Potomac Electric Power Company Buzzard Point plant, Washington, D.C. This Drive is rated at 550 hp, 850/90 rpm. The first Magnetic Drives were installed by this large, rapidly growing utility in 1941.

These E-M Magnetic Drives transmit torque electromagnetically from constant-speed a-c drive motors to vary the speed of the fans. The Magnetic Drive responds precisely to the speed dictated by the automatic combustion control.



E-M MAGNETIC DRIVE SYSTEM for induced draft fan speed control consists of a constant-speed motor, the Magnetic Drive, and the E-M "Regutron" Speed Control. Operating speed of the "magnet" coupled to the fan shaft is held at the desired value by the "Regutron" which supplies d-c excitation to the "magnet" in accordance with the demands of the combustion control system.

Among the advantages of Magnetic Drive speed control you will find:

1. Savings in Driving Power. Because fan operating speed is no more than required, drive power is used most sparingly.

2. Reduced Blade Erosion. When boiler load is reduced and fan speed is reduced accordingly, "sand blasting" effect on the blades by airborne particles is reduced to a minimum.

3. Precise Control of Air Flow. The E-M Magnetic Drive maintains fan speed to within plus or minus *one-half percent!*

4. Easy and Economical Maintenance. The Drive and its control contain few moving parts. It is simple to understand and requires little maintenance. No auxiliary cooling equipment needed.

Ask your nearest E-M sales engineer for more facts and figures on this simple, economical method of driving draft fans. And write the factory for E-M Publication No. 1107 containing pictures and data on typical Magnetic Drive applications.

ELECTRIC MACHINERY MFG. COMPANY

MINNEAPOLIS 13, MINNESOTA

4400-TPA-2151

E-M

Magnetic Drives **MAKE DRAFT FANS DO EXACTLY WHAT YOU WANT THEM TO**

S-A ENGINEERED CONVEYOR SYSTEM HELPS PROVIDE

STEAM from LIGNITE

FOR NORTH DAKOTA STEAM PLANT

General view of lignite burning steam plant of the State School of Science at Wahpeton, N. D. Bucket elevator discharges lignite through twin chutes to storage bunker on the inside.

Bucket elevator lifts ashes 31-feet to discharge to outside ash hopper. Trucks can be loaded by gravity discharge. 57-foot high bucket elevator at right lifts lignite to 30-ton storage bunker inside plant. Stoker hoppers are gravity fed.

S-A engineering and know-how recently combined with the North Dakota State School of Science in developing the lignite handling system shown here. Handling this tricky fuel is but one of many types of problems we have solved for others in the past. May we cooperate with you in working out plans for your fuel and ash handling operations?

Write for specific information, or technical assistance in solving your materials handling problems. No obligation.

SINCE 1902 S-A STEPHENS-ADAMSON MFG. CO.

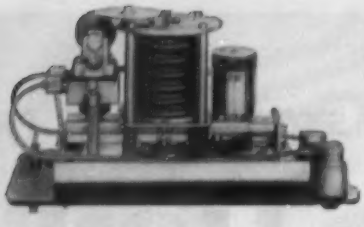
STEPHENS-ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois • Los Angeles, Calif. • Belleville, Ontario

Engineering Division
Specialists in the design and manufacture of all types of bulk materials conveying systems.

Standard Products Division
A complete line of conveyor accessories, centrifugal loaders —car pullers—bin level controls

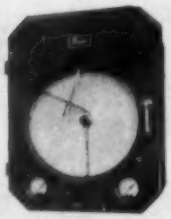
Sealmaster Division
A complete line of industrial ball bearing units available in both standard and special housings



TRANSAIRE* TEMPERATURE TRANSMITTER
Compact and super-responsive. Designed to measure and transmit smallest temperature changes up to 1,000 feet with great accuracy. Provides dynamic accuracy, thanks to derivative action in the measuring circuit. Similar instruments for highly accurate pressure measurement.

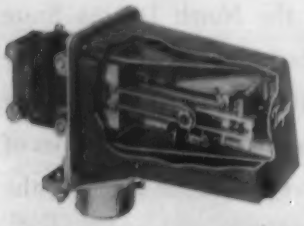
MEASUREMENT AND CONTROL BY *Taylor*

NEW 6" DIAL INDICATOR
For temperature and pressure measurements. Has an all-new design movement for greater sensitivity on any type of measuring job. New case can be flush or face mounted, is fume and moisture proof. Big selection of standard ranges.

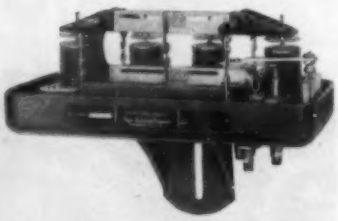


FULSCOPE* RECORDING CONTROLLER
For desuperheaters, or for any close, accurate control of temperature, pressure, flow or liquid level. Quickly adapted to operating requirements.

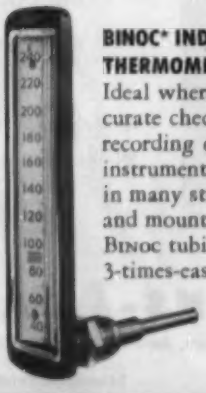
HERE are only six of the many Taylor instruments that will help you increase operating efficiency and cut costs through more efficient measurement or control of temperature, pressure, flow or liquid level. Call your local Taylor Field Engineer now. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



TRANSAIRE DIFFERENTIAL PRESSURE TRANSMITTER
A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Taylor's latest addition to TRANSIT System of transmitters, receivers and controllers.



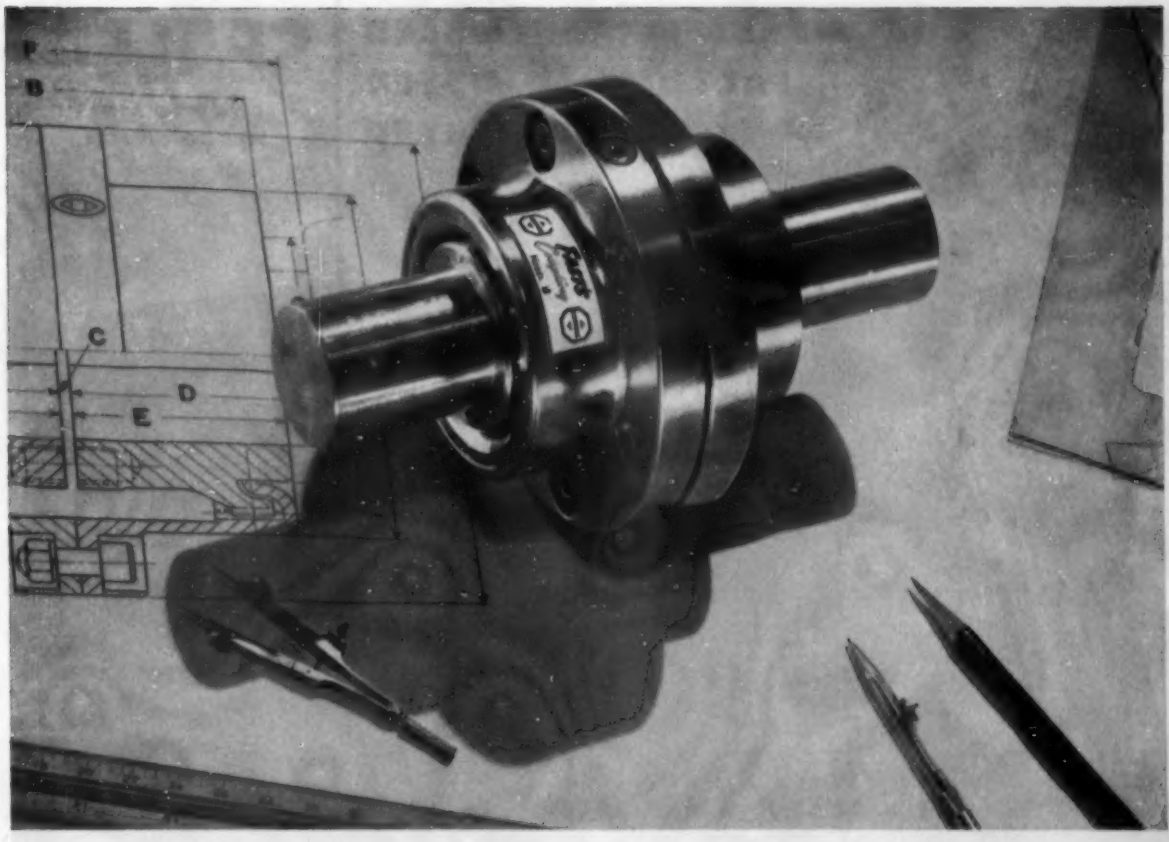
TRANSET* COMPUTING RELAY
A pneumatic, force-balance transmitter for adding, subtracting, averaging and ratioing. For intricate applications requiring close computing accuracy. Handles up to 3 separate pneumatic input pressures with .5% accuracy.



BINOC* INDUSTRIAL THERMOMETER
Ideal wherever an accurate check is needed on recording or controlling instruments. Available in many standard ranges and mounting angles. BINOC tubing makes it 3-times-easier-to-read.

*Reg. U.S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST



Now for the first time, a Fast's Coupling for light and medium drives—at a new low cost!

It's the new Fast's Coupling MODEL B—a lighter, smaller coupling with all the famous Fast's features never before available at such a low cost!

The new MODEL B fills the needs of manufacturers of fans, blowers, pumps and other light-to-medium drive units where coupling *cost* is as important as performance. Koppers engineers designed it to eliminate the cost barrier and offer Fast's rugged design and trouble-free performance for hundreds of new applications.

All steel, dust and moisture proof with metal-to-metal seal, Fast's MODEL B is available for shaft sizes up to 2⅝". Like all Fast's Couplings, it's *sold with service* . . . Koppers *free* engineering service that guarantees the right coupling for the job.

The new Fast's MODEL B Coupling may offer a profitable solution to your light or medium drive coupling problems. Find out how by writing for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 229 Scott St., Baltimore 3, Md.

THE ORIGINAL **Fast's Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus. *Engineered Products Sold with Service*

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **229 Scott St., Baltimore 3, Md.**
Gentlemen: Please send me more detailed information on the new Fast's Coupling MODEL B.

Name.....

Company.....

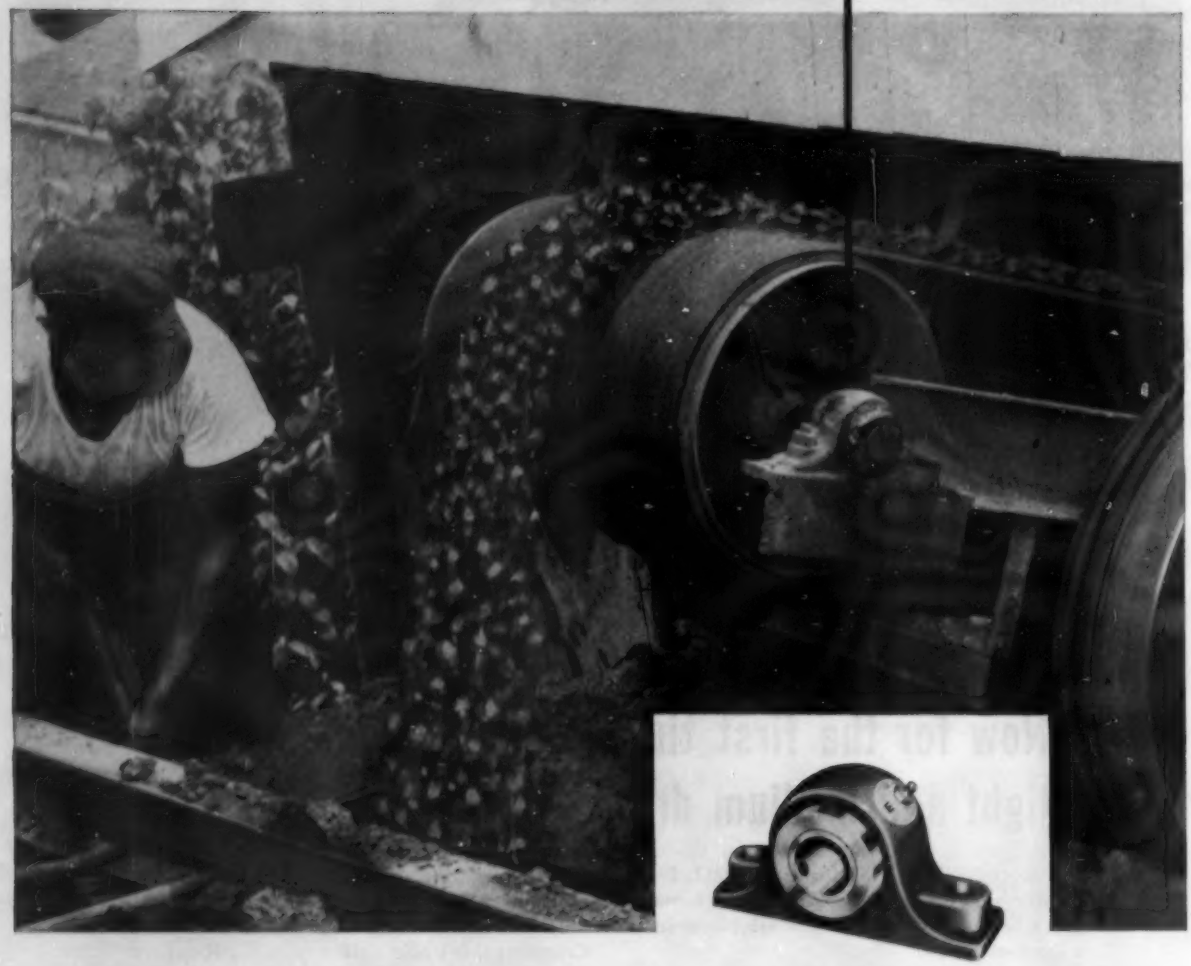
Address.....

City.....Zone.....State.....

COMPLETELY ASSEMBLED
FACTORY ADJUSTED
PRE-LUBRICATED

SEALED

—ready to mount on the shaft!



DODGE-TIMKEN *America's Quality Pillow Block*

Extra measures are taken to build superior quality into Dodge-Timken Bearings; and extra precautions are taken to keep that quality *intact*—from the factory to distributor to you to your machines.

These bearings are sealed in manufacture—an integral part of Dodge-Timken design. Their inbuilt precision is protected *both on and off the shaft.* That is one reason why they easily deliver a minimum of 30,000 hours of service. Want evidence? Look around you. No other pillow block is so widely used on the nation's tough jobs. Dodge-Timken dependability has been proved in *millions* of installations.

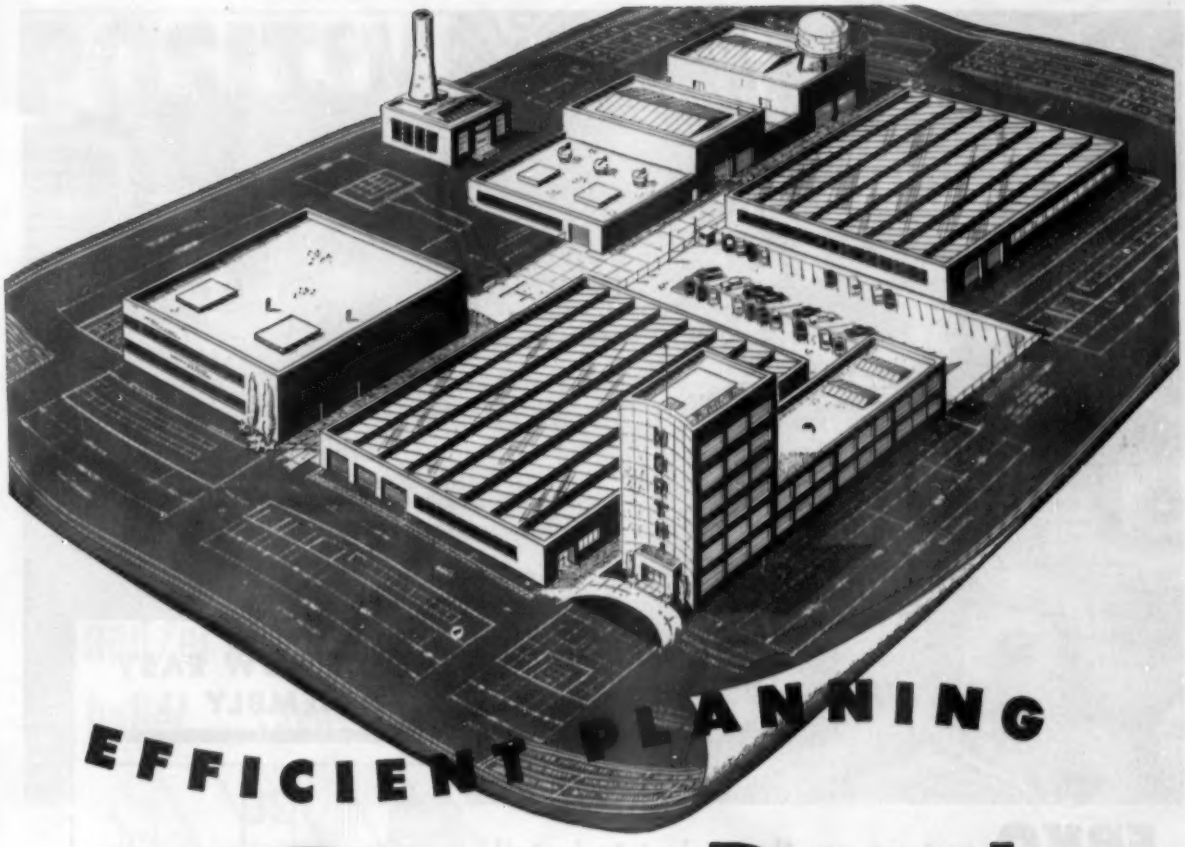
There are 5 types of Dodge-Timken Pillow Blocks for all types of service, in shaft sizes from 1 3/16" to 10". Also Dodge-Timken Hanger Bearings, Flange Bearings, Take-ups.

DODGE MANUFACTURING CORPORATION, 3200 Union St., Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.



EFFICIENT PLANNING

Starts with RIC·WIL

● Early planning with a RIC-WIL field representative on central heating or air conditioning systems will mean less work later on. Custom engineering and prefabrication of RIC-WIL units offer quick, efficient installation. RIC-WIL's engineering service with forty-five years experience in the Insulated Piping Field is available for *early* planning and consultation.

Write or phone your nearest representative or send for the illustrated RIC-WIL catalog.

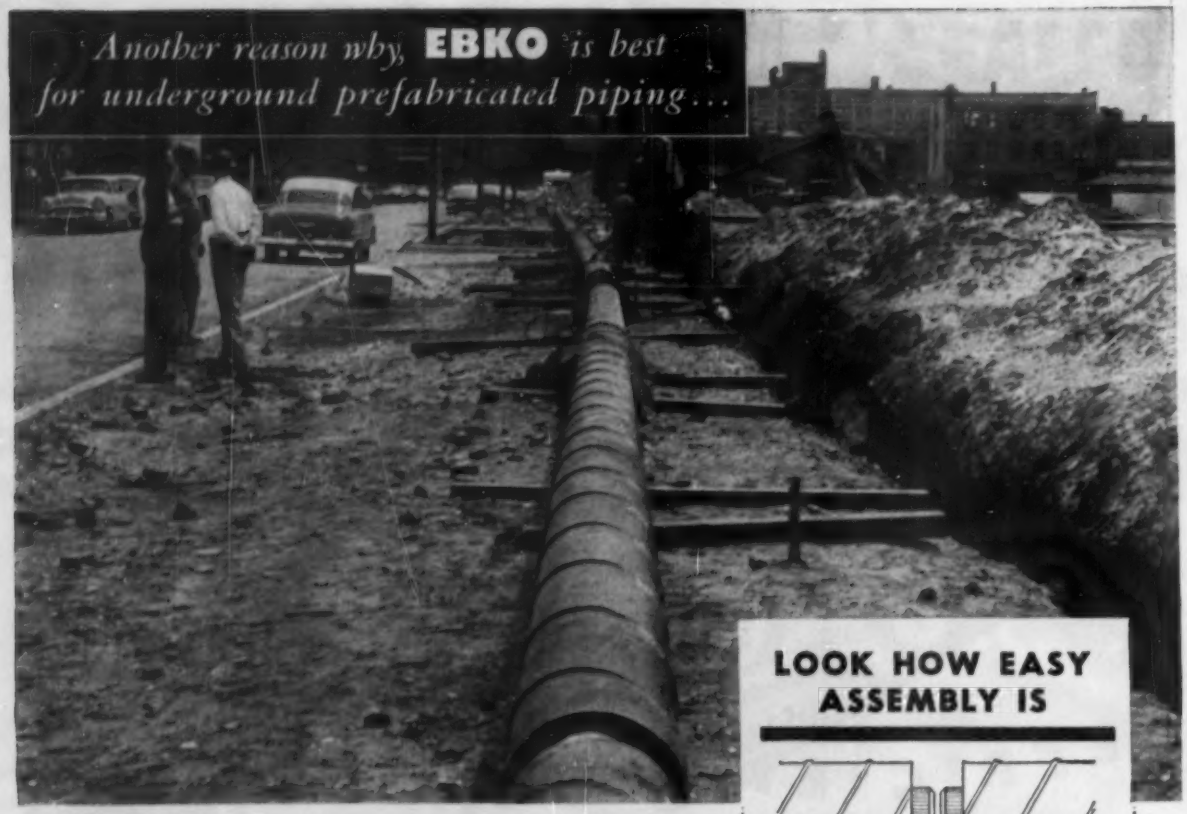
Quality Piping Systems of the . . .
. . . Highest Thermal Efficiency

RIC·WIL INCORPORATED

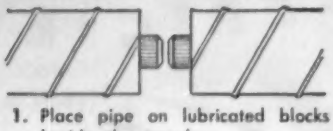
PREFABRICATED INSULATED PIPING SYSTEMS

BARBERTON, OHIO

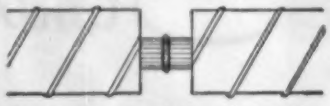
Another reason why, **EBKO** *is best for underground prefabricated piping...*



LOOK HOW EASY ASSEMBLY IS



1. Place pipe on lubricated blocks beside the trench.



2. Align inner pipes, pull together, weld and then test for leaks.

3. Apply split insulation and band in place.

4. Pull casing together, weld and test.

EBKO systems are the easiest to install

A complete EBKO prefabricated insulated underground piping system can be installed in less time and with less work than other prefabricated systems. Here's why:

A plan layout accompanies every system with all pipe, fittings and accessories plainly marked. All parts are shipped in the order of their installation. Beside-the-trench-assembly and 14 gauge *minimum* steel casing strength eliminates necessity for wide or deep trenches. Note on right, simple assembly requires only welding and application of insulation and the welders work upright for the majority of welds.

. . . and remember, *only* EBKO provides steel casing with the Ebko-lok® seam that imparts further crush resistant strength to the casing for positive impact protection.

See your local EBKO Representative—let him show you *all* the reasons for EBKO's superiority or write for details — no obligation.

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Type 1511 is a new all-purpose Consolidated Safety Valve expressly designed for steam generator service. It's a space-saver . . . requires less headroom and smaller discharge piping. The spring is exposed to provide stable operation and uniform blowdown control. Greater tightness is assured because of the precision lapped flat seats. Integral, double-guided combination adjusting ring and disc guide contribute to better alignment, easy blowdown adjustment and finer performance. Full range of sizes and orifices available. Get the whole operational and economy story. Bulletin 730 has complete details. Write for a copy.

SIZES: 1½" through 6". **PRESSURES:** Up to 250 psi. **TEMPERATURES:** Up to 450° F. All sizes except 6" available with oversize inlet flanges.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

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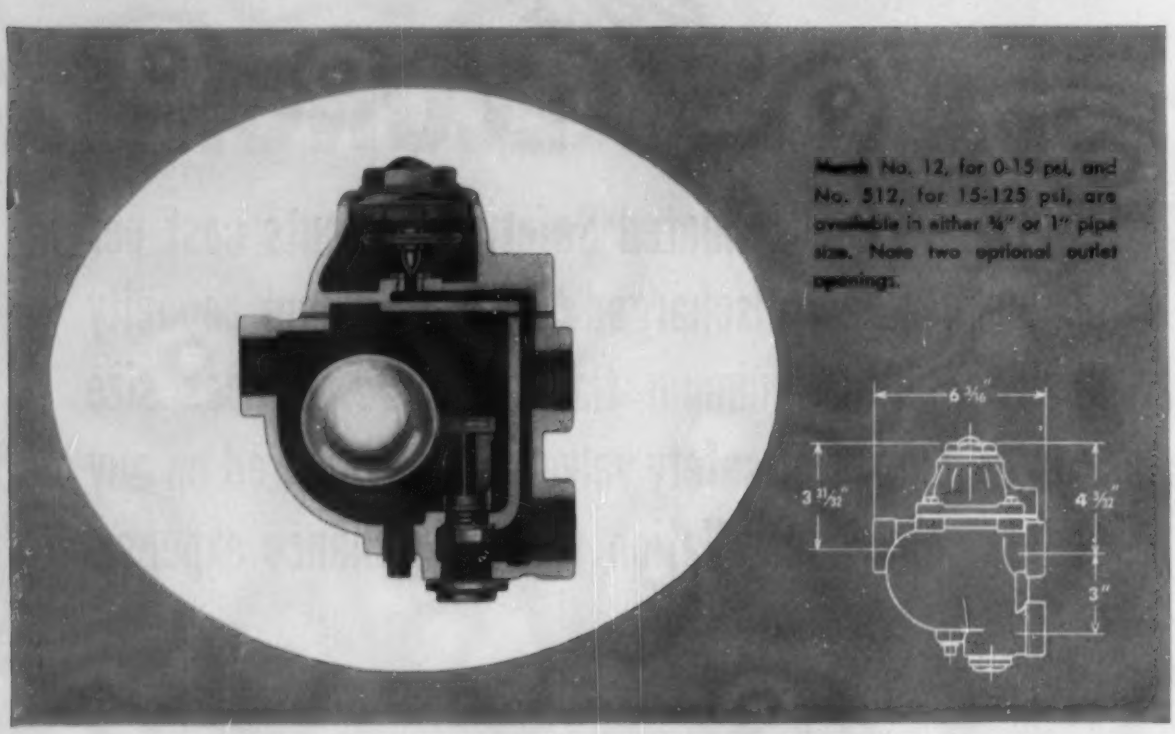
MARSH No. 12

Float and Thermostatic Trap


Marsh No. 12, for 0-15 psi, and No. 512, for 15-125 psi, are available in either ¾" or 1" pipe size. Note two optional outlet openings.
6 3/16"
3 11/32"
4 3/32"
3"

. . . The most dependable trap you can use

There are many jobs that only a float *and* thermostatic trap can handle properly . . . and in the Marsh No. 12 you have the most respected F & T trap ever developed.

Here is a trap that counts its users in thousands. Repeat orders are the rule because men who know have discovered that no other trap can quite duplicate its absolutely dependable, trouble-free performance in removing all air and condensate from steam mains, branches, risers, unit heaters, coils, and similar applications.

Two precision-built assemblies accomplish this. All condensation is discharged by the float-operated valve located at the low point in the trap body. All air is vented through the by-pass by the action of the thermostatic diaphragm, but this is one of those Marsh diaphragms that closes the valve immediately in the presence of steam. In fact the accuracy of response is the attribute that distinguishes the Marsh thermostatic element. It gets the air out and keeps the steam *in!* Another big feature is the straight through design which eliminates troublesome excess piping.

No. 12 is your F & T trap for those low pressure applications — up to 15 psi W.S.P. but its identical-in-operation companion, No. 512, covers the working pressure range of 15 to 125 psi. There is a Marsh trap for every low or medium pressure application.

Write for catalog 76-H covering Marsh heating specialties

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MARSH *Heating Specialties* **SINCE 1865**

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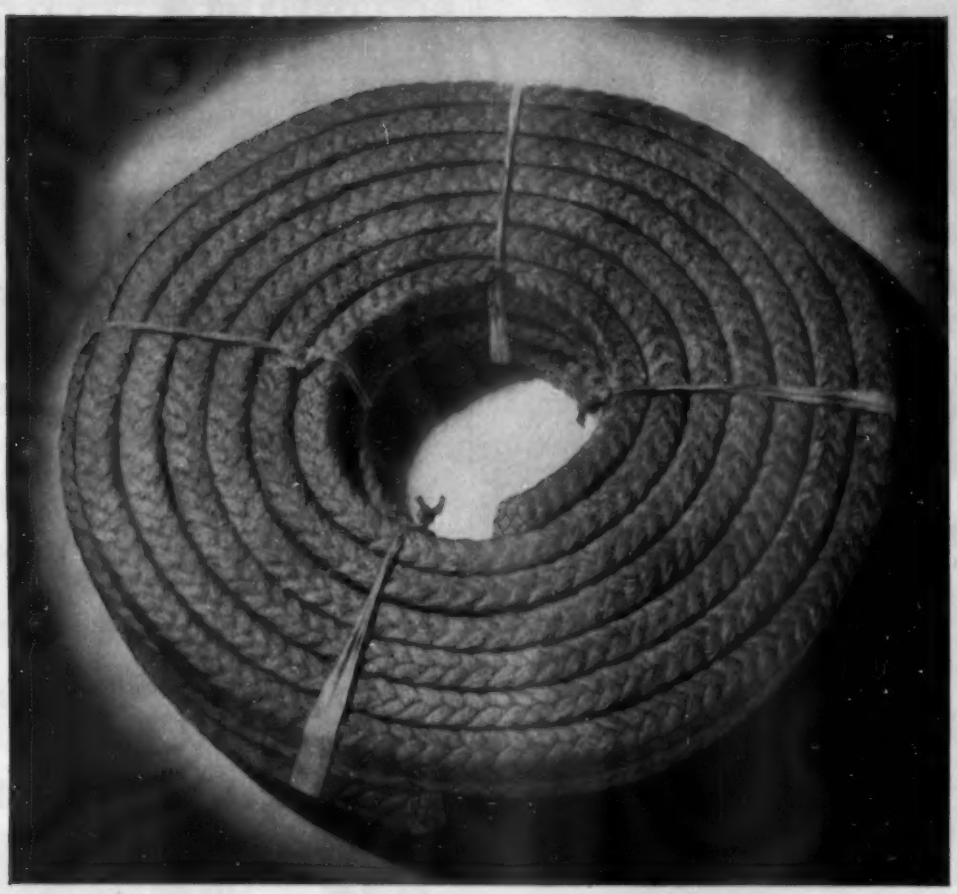

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- **Each strand of yarn is long-fiber asbestos, plaited square.**

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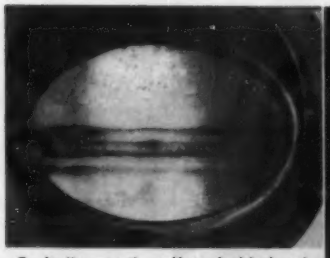
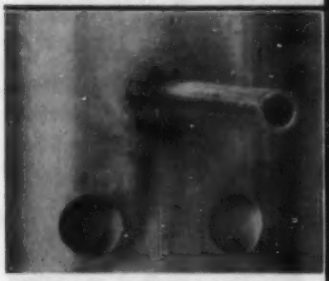
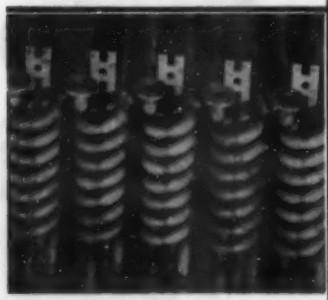


Typically smooth, uniform inside bead in stainless steel piping which results from making root pass with PP&E "free flow" inert gas shielded tungsten arc-welding process.



Stainless steel thin wall tubing is soundly welded to heavy stainless steel body by a skillful PP&E inert gas tungsten arc-welder.

Smooth external surfaces of welds on this component are the result of long experience in welding stainless steels.



Condenser coils of stainless steel, completely prefabricated at Pittsburgh Piping and Equipment Company.

Sound, clean joint having uniform root bead of correct internal contour is result of Pittsburgh Piping's tungsten arc-weld process which provides "free flow" of inert gas on internal and external surfaces of root pass.

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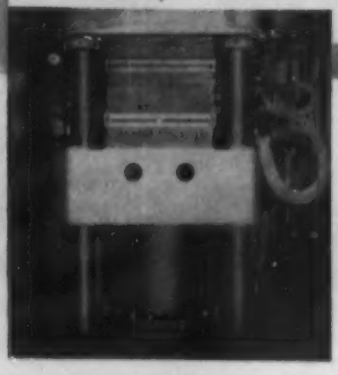

One of the Palmetto Pyramid equipped multiple-ram hydraulic presses in Norristown, Pa., plant of Taylor Fibre Co.

Production efficiency is affected by replacement of short-lived Vee packings used as a ram seal on Taylor Fibre Company's multiple ram, heated platen, hydraulic presses. Service conditions are above normal—2800 psi pure water at 96 F—but continual press operation is vital to production if Taylor Fibre's enviable reputation for prompt service is to be maintained.

Palmetto Pyramid packing, used because of its special heavier construction and rugged design, keeps their presses in operation for an entire year without replacement. Taylor Fibre saves money by reducing downtime, maintains delivery schedules, and pays no more for a packing which gives much more service.

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Perhaps Pyramid or another packing in the Palmetto line will improve the performance of your operating equipment. To achieve better packing performance—longer service life, less downtime—get the assistance of a factory trained Greene, Tweed representative . . . yours for the asking. For further details on Pyramid and other Palmetto Packings, write for Greene, Tweed catalog PC-102.

NOTE: For the name and location of the Palmetto distributor nearest you, see Greene, Tweed's two-color insert at the head of the packing section in Thomas' Register.

packing more performance into every application

GREENE, TWEED & CO. NORTH WALES, PENNSYLVANIA

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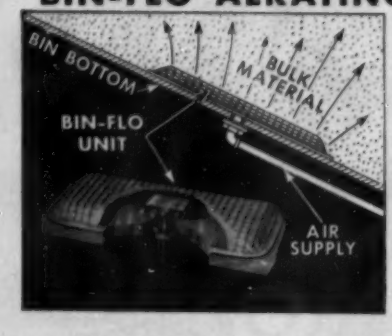

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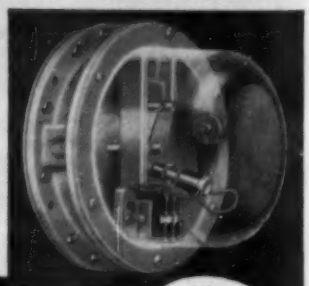
For All Bulk Materials

signals change in level; automatically starts and stops filling and emptying equipment.



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NOW, being used for boiler, manhole, handhole and face plate studs, turbine header studs, flange bolts on high temperature valves, steam lines, pumps, etc.

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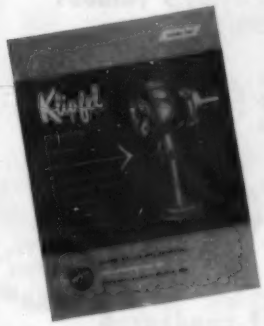
Write Dept. D-9 for any bulletins you wish. We'll gladly send them to you.



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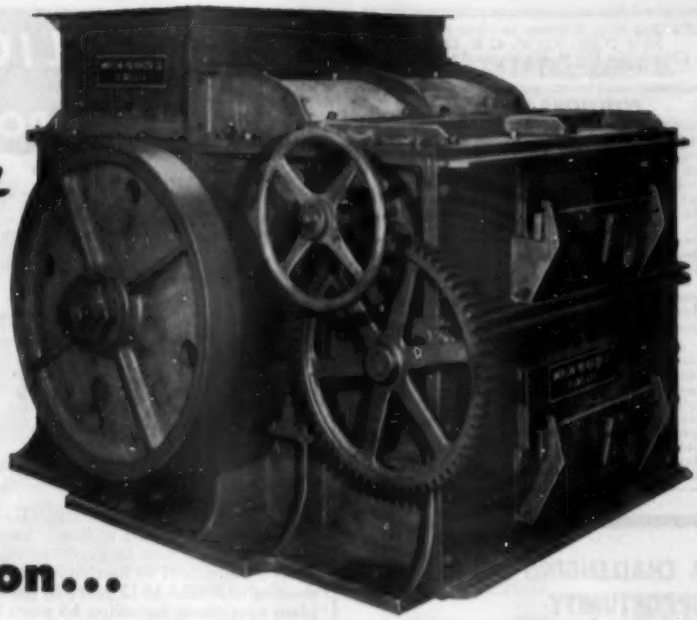
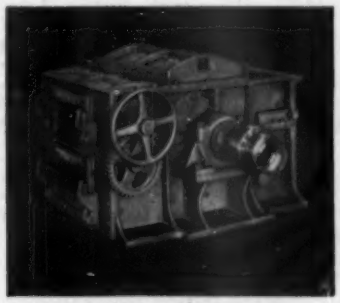


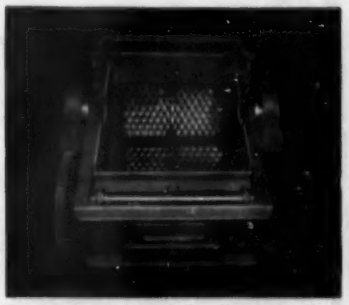
1 Patented Shredder Ring

American-originated feature that splits coal instead of smashing it—for uniform sizing, minimum fines. Result: Americans run at slow speeds, with savings in power and maintenance. No cams, shear pins, toggles.



2 Heavy-Ribbed Steel Frame

Bearing pedestals are cast integrally with lower side frames. Sectional design for easy dismantling . . . abutting joints accurately machined and bolted together for dust-tight fit.

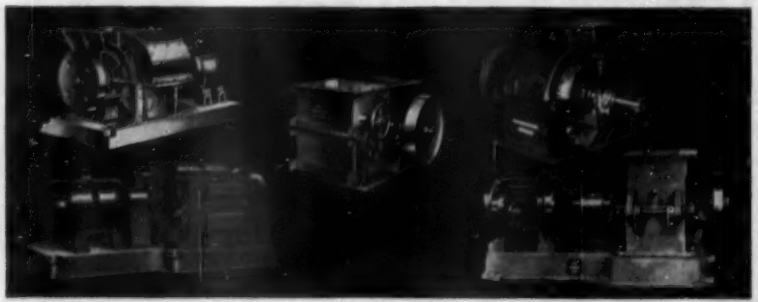


3 Completely Lined Crushing Chamber

Heavy, renewable liners . . . sectional for easy plate-at-a-time replacement . . . engineered to offer life-time protection to the frame.

4 Complete Accessibility to Adjustment and Parts

All adjustments external—even with crusher in motion. Rotor easily reached by removing top section. Rings readily reversed or replaced. Liners quickly reached, too, for periodical inspection.



5 Custom-Built to Your Needs

American has developed many crusher types, each in a number of sizes. Custom-designed with the proper crushing elements, grate bars or screen plates to produce the desired product in the quantities required.

They All Add Up!

Whenever you figure cost per ton, the best answers come from American. By actual survey, American Crushers, in use an average of ten years, show a parts replacement cost of only 1/10th of 1¢ per ton of coal crushed!

American PULVERIZER COMPANY

Coal Crushers up to 800 Tons Per Hour • Laboratory Crushers up to 3,000 Lbs. Per Hour

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • SAINT LOUIS 10, MO.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

SEARCHLIGHT SECTION

Classified Advertising

EMPLOYMENT: BUSINESS: **"OPPORTUNITIES"** EQUIPMENT USED OR RESALE

UNDISPLAYED —RATES— DISPLAYED

$1.50 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Position Wanted undisplayed advertising rate is one-half of above rate, payable in advance.

Box Numbers—count as one additional line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

The advertising rate is $17.50 per inch for Equipment & Business Opportunity advertising appearing on other than a contract basis.

Employment Opportunities, $25 per inch, subject to agency commission.

An advertising inch is measured ⅞ vertically on one column, 3 columns—30 inches—to a page.

New Ads: Send to 330 W. 42nd St., New York 36, N. Y. for October issue closing September 6th

POSITIONS VACANT

Engineers—positions available to qualified men for the development and design of centrifugal pumps and centrifugal compressors. Knowledge of basic fluid, mechanics, thermo-dynamics as related to power plant equipment essentials. Worthington Corp., Harrison Division, 401 Worthington Ave., Harrison, N. J.

Wanted: Chief Power Dispatcher—small system 69 and 34.5 KV.—excellent opportunity for man who wishes to live in Mid-west. Write—Southwestern Federated Power Co-op., Box 437, Creston, Iowa.

EMPLOYMENT SERVICE

Salaried Personnel, $5,000-$30,000. This confidential service established 1927 is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. G, P.O. Box 674, Manchester, Vermont.

A CHALLENGING OPPORTUNITY

with

DU PONT

for an experienced

WATER ENGINEER

An unusual career position is now available in the Engineering Service Division of du Pont's Engineering Department for an experienced graduate chemical engineer whose background includes extensive experience in water procurement and treatment for industrial plants. Knowledge of water treatment plant operation through practical experience is important.

The successful applicant will provide engineering advice to those designing, constructing, and operating company plants on problems involved in the procurement and treatment of industrial water supply.

You are invited to send a complete resume, including details of education and experience, to:

Mr. J. C. Costello, Jr.
Personnel Section, Engineering Department

E. I. du Pont de Nemours & Co., Inc.

Wilmington 98, Delaware

POWER ENGINEER

Wanted graduate mechanical or electrical engineer with no more than 3-4 years' experience in steam electric generating plant, hydraulics, refrigeration, instrumentation, and lubrication engineering.

Will assist in planning, design and direction of 14 boilers, 18 mm. lbs.-a-day steam plant, 15,000 k.w. generating plant and 22,000 k.w. electric distribution system.

Excellent working conditions. Located in city of 70,000. Liberal company benefits. Five day, forty hour week. Please send complete resume to Personnel Department.

A. S. STALEY MFG. CO.

Decatur, Ill.

POWER PLANT SUPERVISOR

(Ages 35-45)

Career opportunity with major U. S. oil company operating in South America. Candidates must be graduate engineers in electrical or mechanical engineering and have 10-15 years in power plant operations, including 4-6 years in over-all supervisory capacity and specific experience in the start-up of new power plant units of at least 15,000 KW capacity. Position duties include the supervision of operation and maintenance of gas fired power plant consisting of six turbo-generating units totaling 42,500 KW. Salary and bonus equal approximately $15,000. Liberal benefits, tax savings and home vacations with travel expenses. Interviews will be arranged for candidates whose resumes indicate potentiality. Replies confidential.

Box 1221
Dept. U-47
New York 1, N. Y.

. . . ENGINEER CHIEF . . .

STEAM PLANT

Cold Seal license. North Jersey Chemical Mfr. Send complete resume including salary desired.

P-7376, POWER
330 W. 42 St., New York 36, N. Y.

OPENING AVAILABLE AT LONG ESTABLISHED MEDITERRANEAN COPPER PROPERTY

ASSISTANT CHIEF ENGINEER

Age limit 45 preferably about 35. Must be graduate mechanical, chemical or civil engineer with natural mechanical ability, excellent practical and supervisory and some construction experience, for charge under Chief Engineer of all shops, foundry, mobile equipment including loading, marine, railway and construction; maintenance and repair of all types of equipment; 7250 KVA diesel generating plant.

Forward with initial reply complete educational and experience records, list of references, age, marital status, number and age of children, photo (optional). Company offers three year contract, furnished house, transportation self and family, liberal vacations. Excellent climate, living conditions, medical and hospital facilities. School to 14 years. Non-contributory pension plan. Salary open.

P-6780, POWER
1111 Wilshire Boulevard
Los Angeles, California

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

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POCKET SIZE • LOOSE LEAF

Loose leaf, 6 hole, 6¾"x3¾" hand paper, each book approx. 140 pages of technical data for student, engineer, technical worker. **$1.25** ea.

Architecture	General Math	Phys. & Therm. Data
Home Heating	Math Tables	Physics
Illumination	Physics	Metals
Electrician's Data	Trig-Log Tables	Metallurgy
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Lumber Data	Chemical Tables	Radio
Air Conditioning	Analytic Chem.	Television & FM
Building Constr.	Mech'l Drawing	Electricity, AC
Reinf. Concrete	Machine Design	Electricity, DC
Piping Data	Machinist's Data	AC Motors & Gen'trs.
Surveying	Mech. of Materials	Transformers, Relays & Meters
Surveying Tables	Pwr. Trans. Mach.	
Highway Eng'g.	Thermo. Tbls.	

Write for FREE catalogs (2000 listings). Send $1.25 book or $6 for any five books to

LEFAX PUBLISHERS, Dept. PO-9, Phila. 7, Pa.

HYDRAULIC TURBINE SERVICE

Cavitated and Damaged Runners Repaired

Cast Iron, Cast Steel,
Bronze and Stainless: Emergency
Services: Inspection and Supervision
Services: 30 years experience

- Use of stainless steel for cavitation repairs for long life
- Work performed in place on runners where damaged areas are accessible
- Cracked stay rings repair-welded
- Draft tubes and liners repaired and replaced

SERVICE ANYWHERE

Write for Bulletin No. 501

Welding Engineers, Inc.

Norristown, Pa. **Phone: 8-6900**

NEW PRODUCT WANTED

Old established Southern Connecticut engineering firm, with excellent steel fabricating facilities, is interested in manufacturing and marketing a new product. Industrial or power plant item preferred. All replies will be reviewed by Corporation President.

BO-7175, POWER
330 W. 42 St. New York 36, N. Y.

2000-KW. at 80% PF., 2500-KVA.

A MODERN WESTINGHOUSE, 400# psig., 750°FTT., 2300-V. CONDENSING TURBINE-GENERATOR AN EXCEPTIONALLY GOOD MACHINE

Unit is Complete with All Operating Auxiliaries.

Other Condensing Turbines Available:

ABOVE PHOTOGRAPH SHOWS MACHINE IS OF MODERN DESIGN

3000-KW G.E., 400# psig., 750°FTT., 1500-KW., 400# psig., 750°FTT. 3000-KW. Westinghouse, 400# psig., 750°FTT. All 2300-V. MANY OTHERS.

WE CARRY A FULL LINE OF DIESEL ENGINES AND BOILERS. *Send Us Your Specifications of Anything Wanted.*

PHONE. WRITE OR WIRE.

CHARLES WEAVER
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

TEL. BROADWAY 3-1901.

FOR SALE

1—Worthington Deserating Heater, 92,660 lbs. per hr. 1800 Gal. Storage, 3-20# working pressure.

2—6x6 New Worthington Power Pumps.

VALVE AND SUPPLY CO.
378 Bedford Ave., Brooklyn 11, N. Y.

3—683 CFM—XLE COMPRESSORS
3 INGERSOLL RAND 125 HP, 220/440 V. NEW 1953.
90 HP CYCLOTHERM STEAM GENERATOR
1—125 LB. PRES. PACKAGE BOILER OIL FIRED.
45 TON WHIRLEY CRANE
1 CLYDE E20—100' BOOM ELEC.
DARIEN
60 E. 42nd St., N. Y. 17, N. Y.

50 HP 200 lb. Pressure Erie City Boiler
3000 #6000 & 1600 #3200 Amp. Ckt. Breakers
20,000 gal. Elevated Water Storage Tank
2000 KW 450 lb. Pressure Turbo Gen. Set
100 HP #584 Kewanee Oil Fired Boiler
2—100 HP Crane or Mill Type Motors
4000 KW Frequency Changer Set—Excellent
120,000 lb. F/M Truck Scale—Rebuilt
H. & P., 6719 Etzel, St. Louis 14, Mo.

This is

CHICAGO *Electric Co.*

. . . the right combination of facilities, service and skill to solve your industrial power problems.

We Carry Complete Stocks of
GUARANTEED "REBUILT" EQUIPMENT
WRITE FOR CURRENT STOCK LIST OR PHONE CANAL 6-2900

D. C. MOTORS

HP	MAKE	*230 Volt TYPE	SPD.
250	Westg.	SK-320	450/600
200	Westg.	SK-301	650
200	Cr-Wh.	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
75/75	Westg.	SK-151	400/1600
50/130	G.E.	MCF	250/1000
50	Cr-Wh.	CMC	700/1100

MOTOR GENERATOR SETS

KW	MAKE	A.C.	D.C.
1000	G.E.	13,200	600
500	Westg.	2300	250
400	Al-Ch.	2300	120/240
400	G.E.	2300	270
300	G.E.	2300	250
200	G.E.	2300	250/275
200	Westg.	4160/2300	275
200	Ridgeway	2300	250
175	G.E.	440	125
150	Al-Ch.	2300	275

SLIP RING
MOTORS
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
2000	*G.E.	MT	600
1500	*G.E.	MT-80	240
1250	Westg.	CW	600
1000	*Westg.	CW	450
700	*Al-Ch.	ANY	720
600	Westg.	CW	350
400	Al-Ch.	2 brg.	450
300	*G.E.	IE-15A	1800
300	*G.E.	MT-568	720
250	Westg.	HP-15H	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900
200	G.E.	IM-17	600

SYNCHRONOUS
MOTORS
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	PF	SPD
1420	*West.		.7	900
720	*Westg.		1.0	900
710	*G.E.	ATI	1.0	720
600	*G.E.	TS-7640	1.0	900
500	*G.E.	TS-7607	1.0	514
400	*West.	H	.8	1800
400	West.	HG	1.0	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G.E.	ATI	.8	1200
250	G.E.	ATI	.8	900
250	G.E. (New)	TS-974T	.8**	720
225	G.E.	TS-6244	1.0	300

SQUIRREL CAGE
MOTORS
3 phase 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
1250	*Al-Ch.	ANW	3600
1250	*Al-Ch.	ANW	1200
800	*Westg.	CS	3600
800	*Westg.	CS-1183	1800
700	*Westg.	CS	1200
700	Al-Ch.	AN	900
500	*Al-Ch.	6216-SW	1200
500	G.E.	KT-424	450
400	G.E.	KT-424	360
350	Ideal	A	1800
300	*G.E.	K-6211Y	1200
300	G.E.	K-6253 TEFC	720
250	G.E.	KT-5008	1200
250	*L. Allis	OGK-148	720
250	*G.E.	IK	600
250	G.E.	IK 17A	600
250	Westg.	CS-14	514
200	*G.E.	KT-546Y	3600
200	*G.E.	KT-561	1800
200	*Cr-Wh.	9C	900
200	Al-Ch.	ABWWT	600
200	*Westg.	CS	600
200	Al-Ch.		514
150	Westg.	CS-8150S TEFC	1200
150	Westg.	CS-8756C TEFC	900
150	Wagner	108-1, 21-v	900
150	*Westg.	CS	600
125	*Westg.	CS-771, Sp-pf.	1800
125	Cr-Wh.	(2) Size 5QR	1200
125	Reliance	AA-C60658	900
100	Westg.	CS	1800
100	Westg.	CS-760	1200
75	Westg.	CS	1800
75	G.E.	KT-546	1200
50	G.E.	K-4444 TEFC	1800
50	Westg.	CS-447	1200

CHICAGO *Electric Co.* 1320 WEST CERMAK RD. CHICAGO 8, ILL.

There's more than 40% to 60% SAVINGS

SCHOONMAKER DEPENDABLE
DIESEL POWER

because:

Each Schoonmaker-sold Diesel Engine Unit is fully REMANUFACTURED in our plants by highly skilled, factory-trained Diesel engineers. Only genuine factory-made and approved parts are used and all REMANUFACTURING is in strict accordance with manufacturer's recommended procedures. Prior to shipment every engine is subjected to a FULL LOAD operating test in accordance with DEMA standards.

The Schoonmaker Plants and Warehouses located in Eddystone, Penna. and Sausalito (San Francisco), California give NATIONWIDE SERVICE from Coast to Coast with modern, efficient and reliable facilities.

Our reputation and many years of experience and SPECIALIZATION in Diesel power equipment gives you value that money cannot buy elsewhere.

So—Buy SCHOONMAKER because you buy the FINEST in DEPENDABLE DIESEL POWER.

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1189	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
675	Fairbanks Morse	38D	960	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	Fairbanks Morse	32E14	450	300
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

ALTERNATING & DIRECT CURRENT UNITS STANDARD AND SPECIAL VOLTAGES AS REQUIRED

*—Indicates NEW unit

ONE YEAR GUARANTEE!

A.G. *America's largest source of New and Remanufactured Diesel Power*

SCHOONMAKER CO., INC.

50 CHURCH ST., NEW YORK 7, N. Y.
PLANTS AND WAREHOUSES:
Eddystone, Penna. and Sausalito (S.F.), Calif.

WANTED

Steam Engine Generator Sets • Turbines • Condensers • Generators • Boilers • or Complete Power plants.

PAUL OBERMAN
1910 Delmar St. Louis, Mo.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make		Speed
600	2300	Whse.		450
500	2300/4000	G. E.		900
450	440	Whse.		514
450	440	Whse.		720
300	2300/440	G. E.		720
300	440	G. E.	(hoist)	600
300	2300	G. E.		1200
300	440	Whse.		2000
300	440/220	Whse.		600
250	550/440	G. E.		1200
200	440/220	Whse.		514
150 (3)	440/220	G. E.		720
150	2300/440	G. E.		600
150	440/220	G. E.	(hoist)	600
125	440/220	G. E.		900
125	550/440	G. E.		1200
125	2300	G. E.		600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
600	2300/440	G. E.	ATI	720
375	440/220	Whse.	G	900
256	440/220	Ml. Machy.	Syn.	1200
300	2300/440	G. E.	TS	720
300	2300/440	G. E.	TS	1200
250	2300/440	G. E.	TS	720
150	440/220	Whse.	HR	277
125	440/220	G. E.	ATI	600
125	440/220	Whse.	HR	600

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G. E.	PT	3600
500	2300/4000	Elliot	BC	1800
500	2300	G. E.		450
460	2300/440	Whse.	CR	720
300	2300	L. Allis	PR	1800
250 (3)	2300/440	G. E.	KT	1200
200	440	G. E.	JK	720
200	440/220	G. E.	KT	1800
200	2300/440	G. E.	JK	600
200	2300	G. E.	KT	1800
150	440/220	Whse.	CR	900
150	2300	Al. Chal.	AH	1200
150	220	Whse.	CR	1200
150	440/220	G. E.	JK	450
150	440/220	G. E.	KT	720
150	2300/440	G. E.	KT	600

A. C. GENERATORS

1—220 kva, 600 rpm 2300/440/220 V., G. E.
1—360 kva, 900 rpm, 440/220 V., G.E.
1—235 kva, 90 rpm, 220/440 V., G.E.
1—300 kva, 720 rpm 2300/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2300/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V., G.E.
1—FKR-143, 1200 amp., 4160 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
90	230	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2300	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/2300	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2300/440	Syn.	125
65	G. E.	2300/440	sq. ca.	250

TRANSFORMERS 60 Cy.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—300 kva, G. E., 2300—575 V.
3—250 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—440/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

FOR SALE

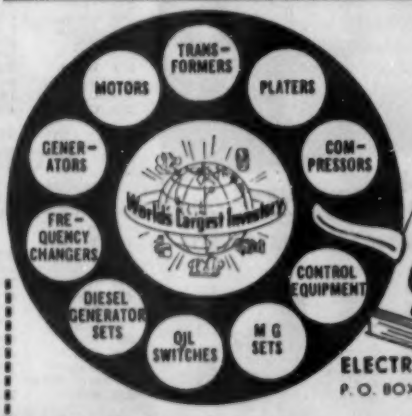
6—100 KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
6—75 KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
9—37½ KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
19—15 KVA 60 cy. 1 ph. Dry Type 240/480-120/240
15—25 KVA 60 cy 1 ph. Dry Type 240/480—120/240
8—37½ KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—50 KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—10 KVA 60 cy 3 ph. Dry Type 480—208Y/120.
2—37½ KVA 60 cy 3 ph Dry Type 480—208Y/120.

ATLANTIC TRANSFORMER CO.
5143 N. 2nd St., Phila. 20, Pa.
Phone: Michigan 4-6963

COMPRESSOR DIRECTORY
World's Best Rebuilts

All Makes
Many Sizes
Electric
Steam
Gas
Diesel
AIR
Air for Sale or Rent Since 1902
1 CFM to 5700 CFM
1 lb. to 3500 lbs.

American
AIR COMPRESSOR CORP.
DELL AVE. & 47th ST.
NORTH BERGEN, N. J.
Telephone UNion 5-4848



Phone Station Collect
Glenwood 6783

ELECTRIC EQUIPMENT CO.
P. O. BOX 51 • ROCHESTER 1, N. Y.

NEW AND GUARANTEED REBUILT
•
BOUGHT SOLD RENTED

SEPT. SPECIAL—F.O.B. Detroit • **4—1500 KW Motor Generator Sets**
2—Westinghouse • 2—Gen. Elec. • 250 V. D.C. 13,800-4160-2400V A.C., Syn.

BELYEA RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS
RE-NU-BUILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES — 15/2500 HP
D.C. MOTORS WITH M.G. SETS & CONTROLS

		MAKE	TYPE	VOLTS	R.P.M.
2200	HP	G.E.	MCF-12	600	400/500
2000	KW	G.E.	Syn.	2300/4600	450
900/					
1400	HP	G.E.	MCF14	550/600	40/62/100
1500	KW	G.E.	Syn.	6600/13200	720
1250	HP	Whse.	Rev.	600	300/600
1000	KW	G.E.	Syn.	2300/4600	720
1250	HP	G.E.	MCF	600	750/900
1000	KW	G.E.	Syn.	2300/4600	720
1000	HP	G.E.	MCF-8	600	350/700
1000	KW	G.E.	Syn.	2300/4160	720
500	HP	Whse.	Mill	600	300/900
500	KW	Whse.	Syn.	2300	1200
350	HP	Whse.	Mill	550	350/850
300	KW	Whse.	Syn.	220/440	1200
200	HP	G.E.	CD-1850Z	250	500/1500
200	KW	Cr. Wh.	Syn.	6900/13200	720

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT-408	2300	300
1	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	293
1	700	Al. Ch.	D.P.	2300	500
1	500	G.E.	MT-413	2300	540
1	500	G.E.	M-574Y	6900	900
1	500	Whse.	CW	550	550
1	500	G.E.	M-569Z	2300	1140
1	400	G.E.	IE-17B	2200	885
1	400	Whse.	CW-980A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2300	435
1	300	G.E.	MT-410	2300	435

SQUIRREL CAGE

1	800	G.E.	KT-572	2300	1150
2	650	G.E.	PPT-550WY	440	3570
1	500	G.E.	K-6345S	2300	1185
2	450	Whse.	CR-1420	2300/4150	354
1	400	G.E.	IE-15B	2300	1165
1	400	G.E.	IR	2200	580
1	300	Whse.	CR	440	1170
1	200	G.E.	IK-17	440	580
3	200	G.E.	KT-557	440	1800
1	150	Whse.	CR-8568	440	880
1	150	Whse.	CR	440	880

SYNCHRONOUS

1	4350	C.W.	8501-SL	13800/6900	514
2	1750	G.E.	ATI	2300	3600
2	2000	Whse.		2300	129
1	735	G.E.	ATI	2200/1320	900
1	500	Ideal	RM	2300/4160	1800
2	500	G.E.	TS-7587	2300	1200
1	450	Whse.		2200	450
1	400	G.E.	TS	2200	400
3	225	G.E.	ATI-1.0 p.f.	440	1800
1	225	G.E.	ATI-1.0 p.f.	440	1800

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4600
1	2000	G.E.	600 25cy	600	11000
2	2000	G.E.	514	600	6600/13200
2	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	C.W.	514	30/115	4000/15000
1	1000	G.E.	720	600	2300/4600
1	1000	G.E.	600	260	6600
2	750	C.W.	514	30/115	2300
1	750	G.E.	900	125/250	2200
1	600	G.E.	720	250	440/2300
1	500	Whse.	1200	115/230	2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	3000	Wagner	HPW-30	3	25400x2400
2	4250	G.E.-Fur.	FOWT	3	13800x2300/87

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/3300
1	3000	G.E.	60/50/60	6600/11000 6600
2	3000	G.E.	60/25	2300/2300/4600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	2500	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 P.T.T. Surface Condenser 3/60/2300/ 4000 V Direct conn exciter.
1	1500	Whse.	Auto. extraction 190 lbs.—600° P.T.T. 60 lb. extraction 3/60/ 240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200 x I.S.P. 8/250 G. Ext. Surface Condenser—3/60/2300.
1	1000	G.E.	Non-condensing 175/200 lbs. I.S.P. 8/20 lbs G.H.P., 480 3/60.
1	750	G.E.	Condensing 265# I.S.P. 440V. 3 ph. 60 cy.—New—1944.

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	250	1000
200	Allis Ch. b.b.	EW	250	850
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
150	Gen. Elec.	RC-16	230	1700
100	Whse.	SK-175	230	850
100	Reliance	681T	550	1000/1800
100	Reliance	651-T	230	575/1150
75	Cr. Wh. TEFC	583	230	850
75	F. Morse b.b.	DH-140	115	1800
60/75	Reliance b.b.	651-T	230	500/1500
50	Gen. Elec.	RF-14	230	500/1200
50	G.E. dynam. (4)	TACS5	230	1000/2500
50	Whse. (2)	SK-143	230	850
40	Whse. (2)	SK-133	230	850
25	Whse.	SK-163	230	300/900
20	Imperial b.b.	D69	230	400/1800
20	Star b.b. (3)	8B	230	1750
25	L. A. TEFC	RNA	230	850

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
350	Allis Ch.	2300/440 AC	125/250 DC
250	Allis Ch.	2300/440 AC	250 DC
200	Whse.*	220/440 AC	85 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 DC
150	Gen. Elec.	220/440 AC	125 DC
150	Whse.	2300/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2300/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	F. Morse b.b.	220/440 AC	125/250 DC
75	Cont. b.b.	220/440 AC	125 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
40	Whse. (2)	220/440 AC	250 DC
30	Gen. Elec. (3)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
30	Allis Ch. (3)	220/440 AC	250 DC
25	Whse.	220/440 AC	125 DC
20	Rel. b.b. (3)	220/440 AC	250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
350	Allis Ch. b.b.	EW	250	1200
175	Allis Ch. b.b.	EW	250	900
150	Gen. Elec.	BG	250	1800
125	Whse.	SK-184	230	1150
105	Century b.b.	1500 amp.	70	1500
100	Whse.	SK-175	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	661T	600	1800
75	F.M. b.b.	DG	125/250	1200
75	Cont. b.b.	D100X	125	1150
75	F.M. b.b.	DG	125	1800
75	Cr. Wh. bb (8)	CCD	250	1150
50	Whse. (2)	SK-143	250	1150
40	Whse.	SK-133	250	1150
25	G.E. b.b. (10)	CD85	250	2200
25	Whse.	SK93	125	1750

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	G.E.	Synch.	2300	514
700	Allis Ch.	Sq. Cage	440	900
700	G.E.	Synch.	2300/440	1200
600	G.E.	Slipring	2300/440	600
500	G.E.	Sq. Cage	4000	1800
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	440	600
400	G.E.	Slipring	2300	600
400	Whse.	Sq. Cage	2300	514
400	G.E.	Synch.	440	450
350	Whse. (2)	Slipring	2300	450
300	Whse.	Sq. Cage	440	600
300	Kl. Machy	Synch.	220/440	600
300	Al. Ch.	Sq. Cage	2300/440	720
300	Whse.	Synch.	2300/440	600
300	G.E.	Slipring	440	300
250	Gen. Elec.	Synch.	220/440	450
250	G.E.	Synch.	220/440	720
250	L.A. (2)	Sq. Cage	2300	1200
250	G.E.	Synch.	220/440	600
200	G.E.	Slipring	2200/440	600
200	Whse. (2)	Slipring	2300/440	720
200	Gen. Elec.	Sq. Cage	220/440	1200
200	Reliance b.b.	Sq. Cage	220/440	1200
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2300/440	900
200	Cr. Wh.	Sq. Cage	220/440	1800
200	Whse.	Sq. Cage	2200/440	900
200	R. M.	Synch.	220/440	1200
175	G.E. (3)	Synch.	220/440	720
150	G.E.	Slipring	220/440	900
150	Whse.	Sq. Cage	220/440	900
150	G.E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2200/440	720
150	G.E. (2)	Sq. Cage	2200/440	720
150	Rel. b.b.	Sq. Cage	220/440	1200
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	G.E.	Slipring	220/440	720
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	Allis Ch.	Slipring	220/440	900
100	L.A. b.b.	Sq. Cage	440	3600
100	G.E.	Slipring	220/440	514
100	G.E.	Slipring	220/440	900

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
700	Gen. Elec.	ATI	2300/480	1200
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
485	Allis Ch.	1 brg.	480	600
312	Gen. Elec.	ATB	240/480	900
275	G. E. 25 cycle	ATI	480	750
225	Kl. Machy.		480	720
215	Gen. Elec.	ATI	240/480	600
156	Whse.	G	240/480	1200
150	Whse.		2300/480	600
75	Kl. Machy.		2300	900
56	G. E.	ATB	240/480	1200
37½	Whse.		240/480	1200

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TELEPHONE MONROE 6-7409

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3—1600 HP Fairbanks Morse Model OP 720 RPM, 1420 KVA FM 3/60/2400 volt generators. New 1949.

1—750 HP Superior 8 cylinder, 400 RPM, 500 KW Elec. Mchy. 3/60/2400 volt generator & auxiliaries.

3—600 HP Alco 6 cyl. 514 RPM, 400 KVA Elec. Mchy. 3/60/440 volts. New 1943.

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507 Locust St., St. Louis 1, Mo.

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3—Kewanee Firebox Boilers, 304 HP, 125 PSI WP, Series 500, Model 590. ASME & Natl. Board stamped. New 1942.

3—153 HP Union Iron Works, 160 PSI. Bent Tube ASME, oil burners.

1—250 HP, B. & W. Stirling, 150 PSI. ASME, comb. gas & oil burners.

2—4' x 135' Steel Stacks.

HEAT & POWER CO., INC.
60 East 42 Street, New York 17, N.Y.
MUrray Hill 7-5280

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltage
1	1000	Amer.	Pyranol	3	4150x480
1	750	G.E.	HT	3	4150x120/240
1	750	G.E.	H	1	4600x120/240
1	750	G.E.	Auto	3	4150x2400
2	500	G.E.	H	1	12200/22, 800Y-2300
1	500	Kuhl	OISC	1	4600x2500
1	400	Pitts.	OISC	1	4150x240/480
1	150	Americus	OISC	1	2400/4160-240/480
3	75	G.E.	Pyranol	1	2400/4160-240/480

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1400	G.E.	514	ATI	4150
1	1000	Whse.	720	MIII	2300/4150
1	1000	G.E.	500	MIII	2300/4150
1	500	Whse.	450	HR	2300
1	300	EM	720	TEFC	2300
1	200	G.E.	600	ATI	440
1	200	Whse.	900	ATI	440
1	175	G.E.	750	ATI	2300
2	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
1	150	Whse.	900	1410	220
2	150	Allis	1800		2300
1	125	RM	1800		4000
1	100	G.E.	900	TS	2200

SLIP RING MOTORS

QU	dP	Make	Speed	Type	Volts
1	600	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AT RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
5	60	G.E.	1800	MT	220

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 3yn
1	1000	Whse.	720	600	2300/4150 3yn
1	1000	Whse.	720	275	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3R
1	300	G.E.	1200	250	2300/4150 3yn
1	300	Whse.	900	250	2300/4150 3yn
1	150	C.W.	600	125	220/440 Y
1	100	G.E.	900	250	2300 3yn
3	97	G.E.	1200	60	4150 3yn
1	75	G.E.	1800	250	230/460 DC
1	60	Whse.	1200	60	2300V
2	60	EM	1200	125	220
1	50	Whse.SK	1750	250	2300V 3yn
1	50	Whse.	900	230	480
2	50	G.E.	1750	240	220/440
1	25	G.E.	1800	230	220 Y 3yn
1	20	EM	1800	125	220 Y
1	7½	Allis	1800	125	220/440
2	5	G.E.	1800	125	220/440
				1 ph	
2	2	G.E.	1800	250	220/440

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	200	G.E.	1200	MPC
2	150	C.W.	900	WP
1	75	G.E.	1760	RC
3	75	C.W.	900	WP
1	50	C.W.	700	CM
1	30	G.E.	860	RC
1	25	Whse.	525	RK

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J. L. HEMPHILL & CO.
600 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK - LONGACRE 5-2277

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Ohio Power Ballville Plant
Fremont, Ohio

3—Allis Chalmers: 5000 KW Turbo Generator Units
3—Condensers: Wheeler Surface Type 7000 sq. ft. 1" O.D. Brass Tubes
3—After Condensers: Alberger size FB-142-B
6—B&W Boilers—500 & 750 H.P.—3 Boilers served by Firite spreader stokers installed 1948
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All equipment in good condition with numerous other items pertaining to complete power house operation.

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1875 KVA 1500 KW 300 RPM

3 phase 60 cycle 2400 volt

Single Bearing direct connected Exciter. Formerly connected to 10 cyl Model 38E16.

In Good Condition

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1—40/20 Century 2 speed motor. 3/60/220—1000/900 R.P.M. Frame 445 with multi-speed magnetic starters and decelerating relay. New in original box. Price $675.00 F.O.B. St. Louis.

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EQUAL TO NEW

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G.M. Model 8-268A—6½x7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

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Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

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Each unit, mounted on a pre-fab sub-base, is 13' 8 5/16" long, 5' 10½" wide, approx. 9' high. Weight of engine and generator only, 17,700 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

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High Pressure, Bent Tube Type
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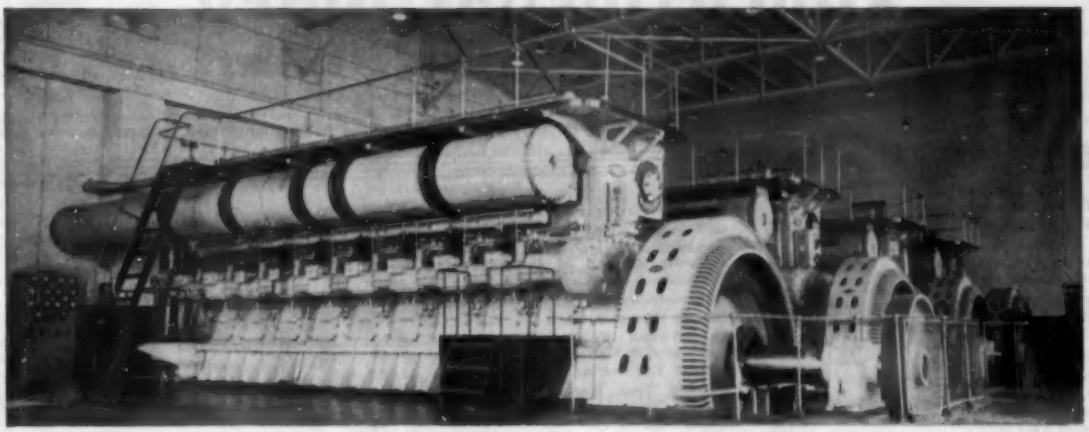
FOR SALE – Complete or As INDIVIDUAL UNITS



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Each Unit Complete with all Auxiliaries. NEW 1943—Can be inspected operating.

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Westinghouse turbine, Max. press. throttle 340# P.S.I.G., Bleeder Station 110# P.S.I.G., Exh. 30# P.S.I.G Satu. Steam. Ser. Nos.—12750 & 12751.

W.H. AC gens., 1563 K.V.A., 480 volts, 1880 amps., 60 cyc., 3600 R.P.M., type SO-2G135, 80% P.F., 3 ph., Ser. No.—4953392-93.

W.H. DC exc., type SK, 16 K.W., 125 volts, 128 amps., 3600 R.P.M., frame 43, sty. No. 2G136.

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Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

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1—3½" x 10" Worthington Hydraulic, Type D1654, 85 GPM, 500 PSI, #978859

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100—1½ KVA, Line Material, Dry type, 120/240/480 volt primary, 120/240 volt secondary, with taps, 1 phase, 60 cycle.
3—150 KVA, Moloney, OISC, 4000 volt primary, 230/460 volt secondary, 1 phase, 60 cycle.
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(1) Model B-12

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250 HP 160 A.S.M.E., Heine, New Tubes. Complete with trim. Immediate delivery—write

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40 Years' Dependable Service

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Actual photograph of corroded condenser tube.

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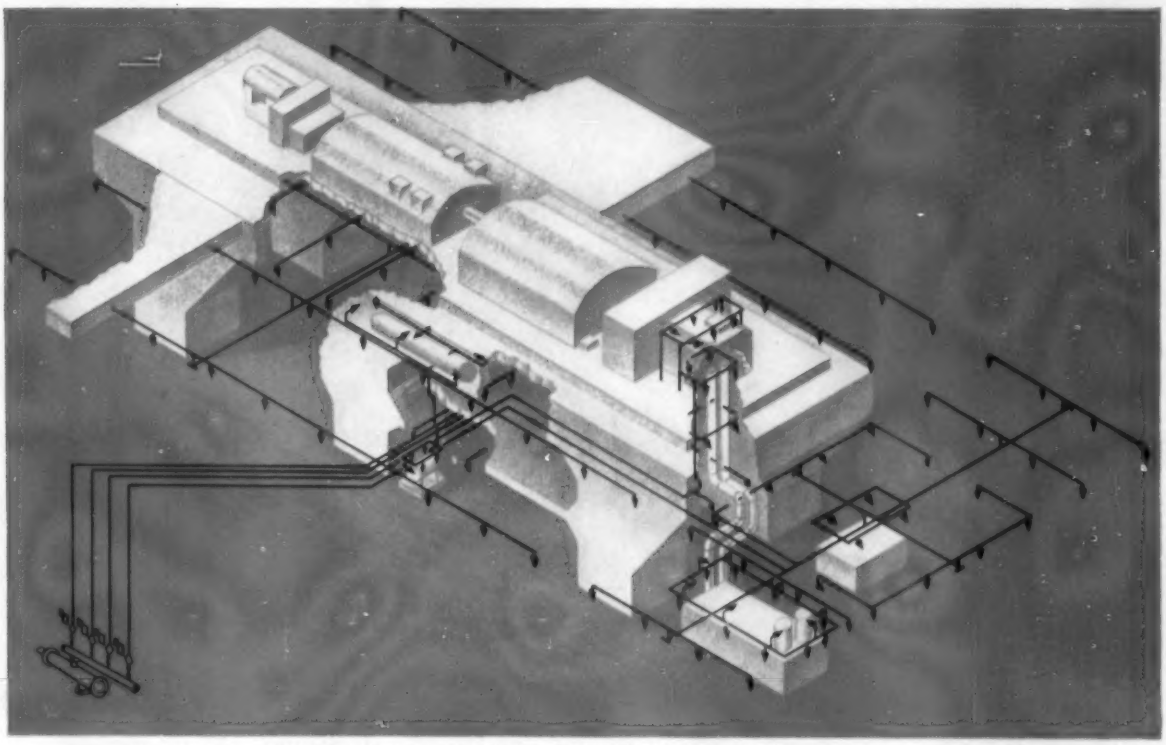

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	200	400	600	800	1000	1200
	Nominal Thickness, Inches					
1½ & Under	1	1	1½	2	2½	3
2	1	1½	2	2½	2½	3
2½	1	1½	2	2½	3	3½
3	1	1½	2	3	3	3½
3½	1	1½	2	3	3½	3½
4	1	1½	2½	3	3½	4
4½	1½	2	2½	3	3½	4
5	1½	2	2½	3	3½	4
6	1½	2	2½	3½	4	4½
7	1½	2	2½	3½	4	4½
8	1½	2	3	3½	4	4½
9	1½	2	3	3½	4½	5
10	1½	2½	3	4	4½	5
11	1½	2½	3	4	4½	5
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14 & Over	1½	2½	3½	4	4½	5½

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